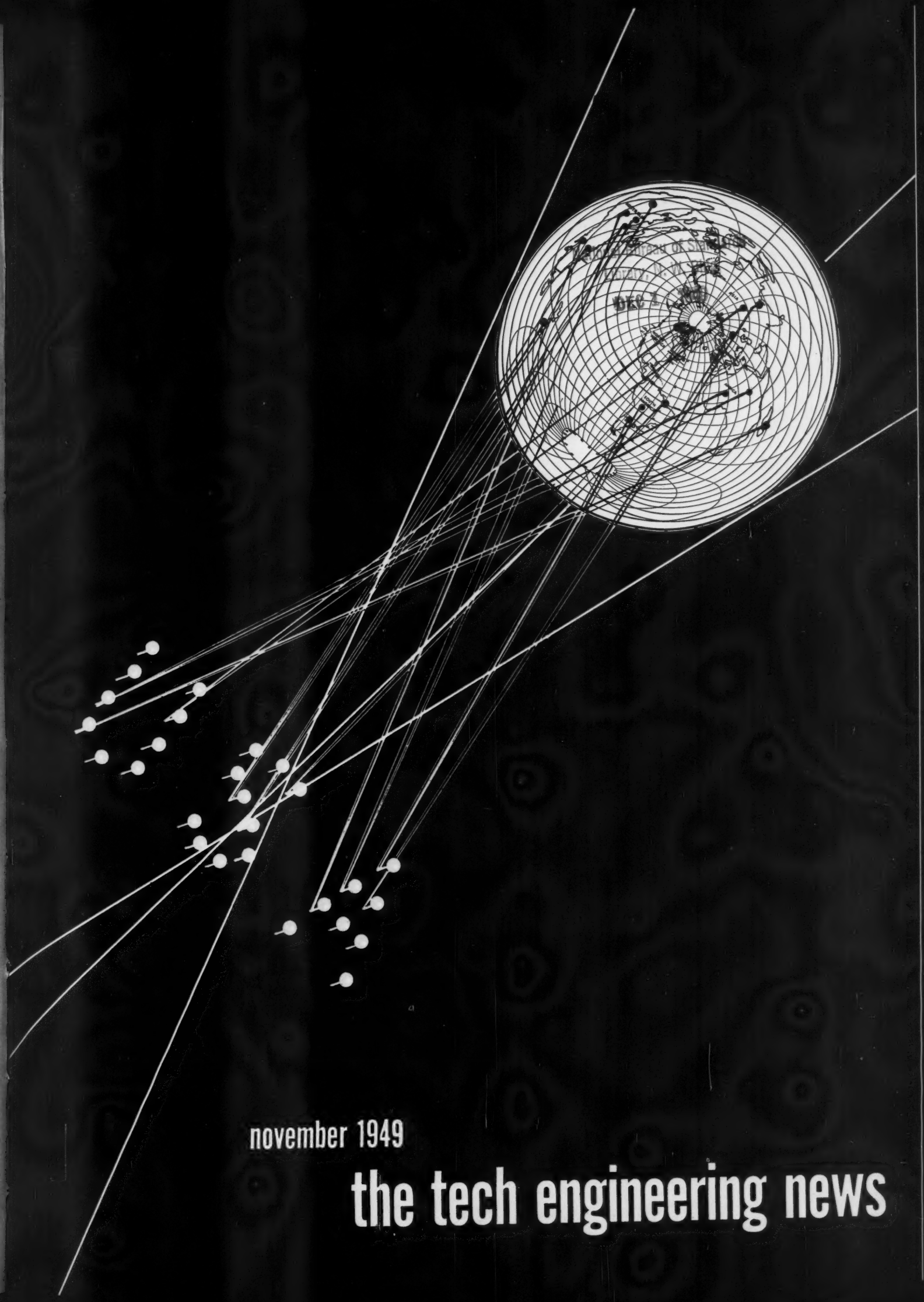

november 1949

the tech engineering news

Another page for **YOUR BEARING NOTEBOOK**

National Bureau of Standards
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New head with a good idea

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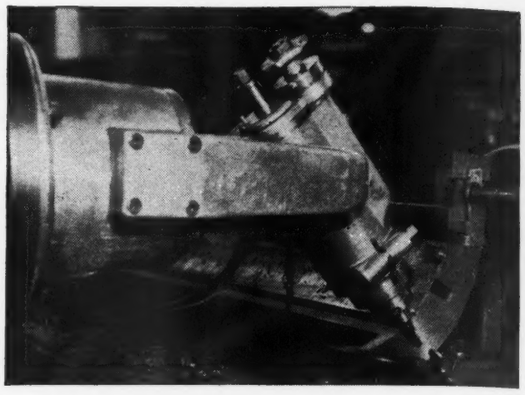
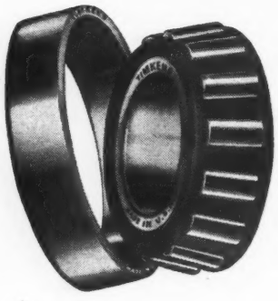
Timken bearings keep the shafts rigid and accurate under heavy radial, thrust and combination loads, eliminate deflection and end-play, reduce wear on moving parts.





TIMKEN® bearings do 9 out of 10 jobs better

Nine out of ten bearing applications can be handled more efficiently by Timken bearings. Some of the reasons why: they carry radial *and* thrust *and* combination loads; *line* contact between rolls and races means greater load capacity; positive roller alignment, true rolling motion, and microscopic accuracy make them almost 100% frictionless; they permit pre-loading to any desired degree.

Want to learn more about bearings?

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50th birthday of the company whose products you know by the trade-mark: TIMKEN

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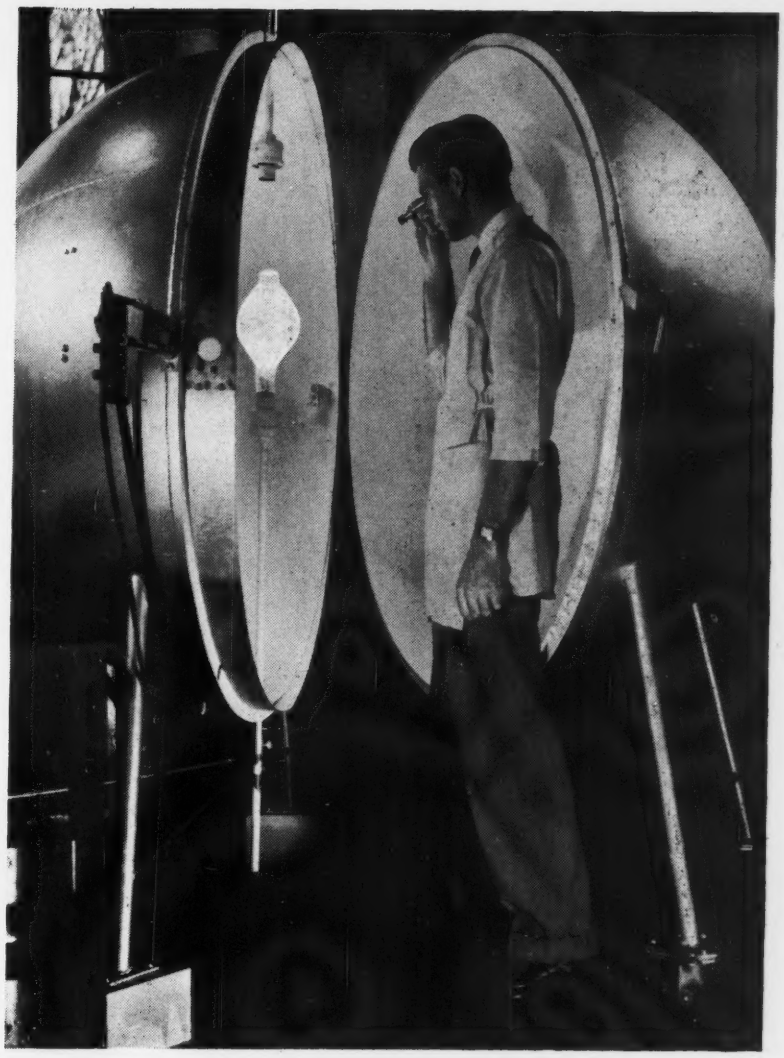
VISION....

Vital Ingredient of a Name



What is vision? An inspired revelation? Or . . . the faculty or sense of sight?

Pick your own definition. They're both important in your future. With Westinghouse, they are both important, too.

Even before the time George Westinghouse dramatically proved the superiority of a-c power distribution, climaxed by his daring demonstration at the Columbian Exposition in 1893, the vision (inspired revelation) of Westinghouse had been repeatedly demonstrated. It's a vision that's burned brightly through the years.

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G-10072

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Want to make a river run uphill?

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EVERY DAY, America's engineers are performing miracles with water . . . creating vast, crystal lakes where valleys were before . . . transporting entire rivers across mountains in steel pipe. But there's still a big job to be done. For 108 million Americans still lack adequate water supplies, and 17 million acres could be made into fertile farms with proper irrigation.

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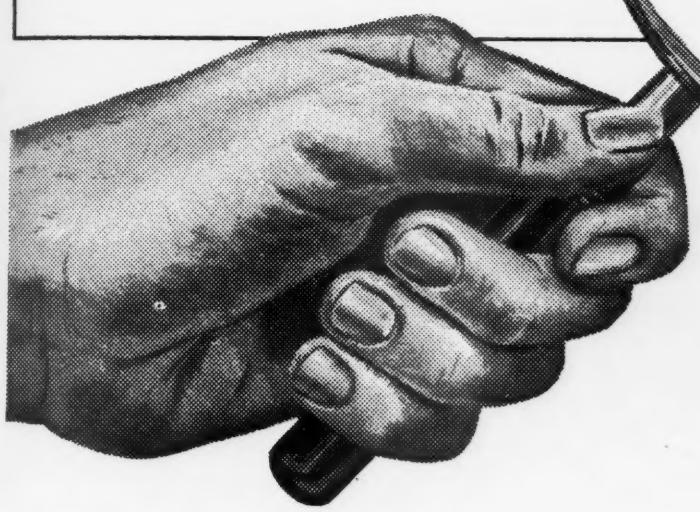

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tech engineering news

November 1949
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capital export

By Vincent R. Murphy, '49

Problems Involved in Spreading the Dollar

Headlines today bring out increasingly the fact of the importance of American capital. In the light of the position of the United States as creditor to the world, it should be of interest to examine more clearly what goes into aiding other nations and developing and exploiting their resources and markets.

The government's plans and activities are served up daily in the newspapers and do not need mention here. The flow of private capital, however, is not as fully comprehended. The most legitimate questions which exist are, perhaps: why should private capital go abroad and, when that decision has been made, under what additional difficulties are managers and investors operating by reason of the international scope of their enterprise?

Despite the clamor on all sides for American dollars, the paradox exists that national restrictions so hinder the immigration of subsidiaries and branches of American business that countries which most need our money are pushing it out and discouraging any influx.

In spite of the attendant difficulties, foreign operations constitute a sizeable segment of United States business. Recent estimates show that some eight billion dollars are invested in some fifteen thousand foreign enterprises spread over all the globe. Largest holdings are in Canada, South America and Europe. The operations which these enterprises undertake concern themselves principally with manufacturing, petroleum exploitation, utilities and transportation, and mining — again in order of dollar importance. In general foreign enterprises use American patents and methods and produce goods similar to those manufactured in the United States.

Financially, the outside concerns are controlled by 100 per cent, or nearly 100 per cent, stock ownership. (This is a general statement, since some nations have laws expressly forbidding such a situation.) Stock control may be direct or through a foreign subsidiary which holds the stock of still another foreign concern. A composite of all organizational structures in 1947 showed 54 per cent of corporation officers and 46 per cent of directors to be United States citizens. A more detailed analysis showed that individual percentages are functions of distance and language, and are subject to the influence of individual national regulation.

The single important reason for the external investment which has been described is to make a profit — often higher outside the United States than in. Only naivete would entertain the thought that service to the world in general and a given country in particular might influence businessmen more than fleetingly.

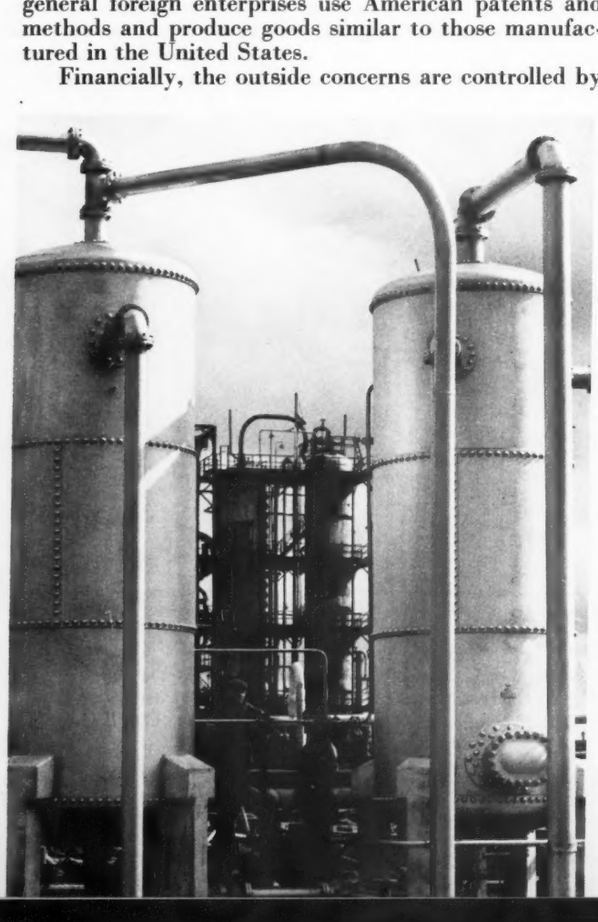
With a profit motive postulated as a matter of course, there must be found reasons for leaving the protected area of the United States. Three general considerations exist which will apply with different degrees of intensity to different cases.

1. The company branching out may feel able to put forth goods at lower prices by manufacturing within the country to which it is at present shipping its product. This reasoning may be brought about by adverse trade laws, particularly high import tariffs. (Often to encourage the influx of outside industry a country will establish high tariffs on finished goods imports and leave raw materials almost entirely alone.) The decision also may be based upon surveys which indicate that reduced prices are permitted by savings in factory, labor or transportation cost, or increased availability of raw materials.

2. When the product sold is designed especially to meet consumer preferences, it is often found that the pulse can best be felt by operating within the country concerned and using nationals in many positions in the plant. Public relations can also be a large factor here.

3. Very often the parent company requires an article made from foreign raw materials which will in turn be a raw material in the main manufacturing operation in the United States.

With this brief look at the scope of United States interest in foreign countries and broad explanation of the motivating forces must be coupled some discussion of international money payments. It is evident that there must be at the least a mechanism which effects the transformation of dollars in the United States into



A storage tank goes up at Standard's Port Jerome, France, refinery.

equipment and supplies in some other country and which effects also the transfer of profits abroad into dollars within the United States. The manner in which these transformations are made can be extremely complicated. There is an infinite number of variations of a somewhat basic pattern.

In the simplest case, the United States exporter has negotiated with the British importer to sell the latter goods. The exporter ships the goods to the importer and draws a draft on him. This draft is an order to pay to the bearer a specified number of pounds sterling. (It may call for payment on presentation or after a specified time. If time is allowed, this is extension of credit, and interest will be paid.) If his credit is good, the exporter can sell this promise to pay to his bank for dollars at the going rate of exchange between dollars and pounds sterling. The American bank then sends the draft to a "correspondent" bank in England with which a deposit of pounds is kept. The English bank will present the draft to the importer and will credit the pounds received to the account of the American bank. In this manner the exporter has been paid in dollars, the importer has made payment in pounds and no money has crossed the ocean.

The situation described has, of course, been simplified to an extreme. A more realistic — but still simplified — transaction takes account of the risk element involved in giving possession of the shipment to a relatively unknown importer before payment is made. While the importer is notified of the shipment's arrival, he does not receive the title to it until he has made arrangements with his bank. The draft is not sent to the foreign bank for collection. It is endorsed (accepted) by the American bank and returned to the exporter. The exporter then may retain the "acceptance" or he may sell it in the market to someone who needs pounds, since it was written in terms of pounds. The balance of supply and demand in these drafts with no regulatory interference sets the foreign exchange rate at which currencies may be purchased.

All business involving transfer of money must work through the foreign exchange mechanism. It is evident that any manipulation of the rates directly or any condition artificially brought about to restrict trade would be of primary concern to firms doing business overseas. Much of the hazard to American "direct investment" in other lands stems from just such activity on the part of governments themselves.

To provide material for comparison, an outline of practices and obstacles discouraging to investors should be preceded by presentation of a set of conditions felt to be ideal. The League of Nations "Special Joint Committee on Private Foreign Investment" has made a series of recommendations and has considered both the long range advantages to the countries affected and the positions of the investors who risk their money. The result is a reasonably fair and unbiased look at what might easily be termed the ideal situation for direct investment. The main points are given here:

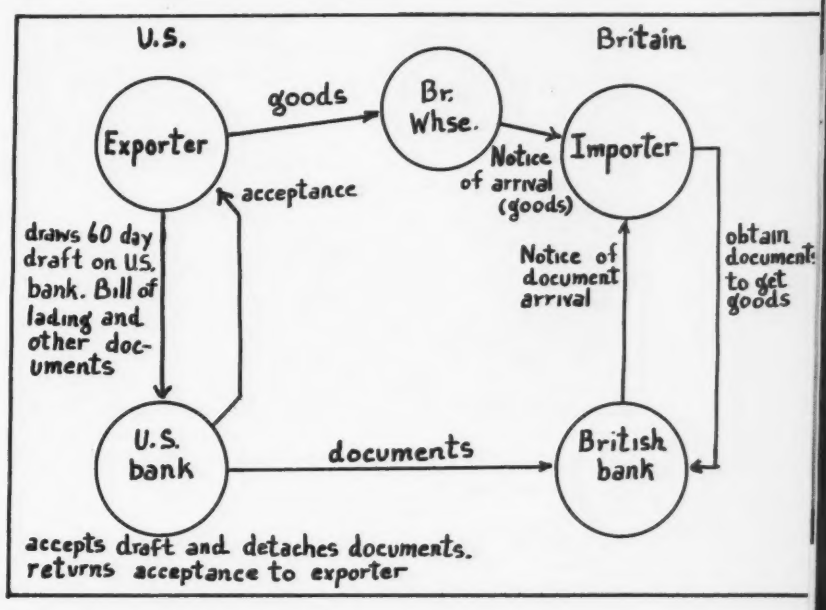
General legislation in capital importing countries should permit business to function restricted only as required for the safeguard of national security and integrity, the protection of individual rights, the orderly development of the national economy and steady promotion of social welfare.

Public finance should be so managed as to contribute to economic stability. Chronic deficits which lead to inflation and debt repudiation undermine confidence and may check enterprise.

Taxation should be so devised as to have the least possible adverse influence on business venture and investment. Income taxes are the least discouraging to enterprise provided the rates are not unreasonable.

It is unwise for capital-importing countries to subject foreigners to discriminatory and extra-territorial taxes. They should refrain from applying any transfer or foreign exchange tax on the service and repatriation of foreign capital. They should, moreover, negotiate with other countries treaties for the prevention of international double taxation.

The success of international investment depends upon measures of international economic policy tending to restore a world-wide multilateral trading system so as to open transfer routes from capital importing to capital exporting countries through third countries. Any check to multilateral trade reduces the transfer capacity of debtor countries.



Legality, equity and good faith are of cardinal importance in the treatment of foreign investment. The fundamental principle on which the civil status of foreigners should be based is that they should have the same non-political rights as nationals and equality of treatment in business and tax matters.

Restrictions on the employment of foreigners and provisions requiring their progressive replacement by nationals in firms where they are employed may reduce the supply of foreign capital.

When measures of expropriation or nationalization are adopted, they should provide for appropriate compensation, in fully transferable currency, before the owner is dispossessed. Greater security to the owner will be assured if this compensation is fixed by a board of independent referees.

Foreign investors can expect to receive fair treatment assuring the security and remuneration of their investment only if, besides offering a direct return, it is a contribution to the economic development and social welfare of the country.

The governments of countries desiring to foster investment abroad can hasten the abandonment of restrictive policies against their nationals in other countries by conducting their foreign relations in a manner which dispels any fear of imperialism or disregard for the principle of juridical equality of nations.

With these criteria as background, the practices generally subscribed to by the nations of the world can

Oil is one of the biggest examples of private United States capital invested in foreign lands.

be reviewed in a critical light. The expected, non-legislated, risks of foreign investment are simply the ordinary uncertainties of business adventure coupled with the additional uncertainties resulting from possibilities of governmental overthrow and exchange rate fluctuations. Prolonged disequilibria in the import-export relationship of a nation may reduce greatly the value of its currency under free market conditions. Such a value reduction would reduce the effective return to security holders outside the country. While the possibility for appreciation also exists, most businessmen prefer to leave the unpredictable element out of their long term operations.

To these dangers, which will it appears always be present, the nations of the world have added a formidable list of obstacles which are often more discouraging because they involve not risks but sureties.

First and most important of this list are the many direct restrictions on the transfer of funds. These restrictions are caused by the dollar shortage now prevalent throughout the world. Countries imposing the regulations feel that not sufficient benefit is entailed in just permitting foreign firms to operate normally; they believe that the immediate solution to an internal shortage of dollars is to prevent their removal.

This prevention is achieved in many ways. The British Commonwealth of Nations saw fit to permit trade only among the nations of the Commonwealth, making outside purchases only of products not obtainable within their sphere. The object is perfectly clear — if no buying is done no money can leave. This approach may solve for these countries their immediate problems, but its long range effects may be dangerous to international welfare and achievement of a balance of trade.

Many countries, notably those in Central and South America, possess no large internal trading possibilities. They, in general, control the exportation of money by less direct and less absolute curbs than this. These take the form of limitations in the number and size of remittances (money orders) and of specific designations of what percentage of profit can be removed. The regulations cover the range from almost unimpeded transfer in Venezuela to the case of Argentina which now permits to be taken out in profits and capital combined only the amount of the original dollar investment.

The most universal device now in use in Latin America to conserve dollars is the multiple exchange rate. A government-controlled rate is in existence at which imports are paid for. It always overvalues the currency of the country which establishes it. A free rate is at the same time used which reflects more nearly the real value of the country's currency. Thus in Peru in July 1948 the government set 6.50 sols to the dollar, while the free market rate was 14.50 sols. Outgoing capital must ordinarily go through the free exchange. By these means, importing materials and goods and remitting money are both made expensive processes. While the object of such measures is simply to maintain the country's internal dollar supply, their parallel effect is to disturb seriously the activities of foreign business.

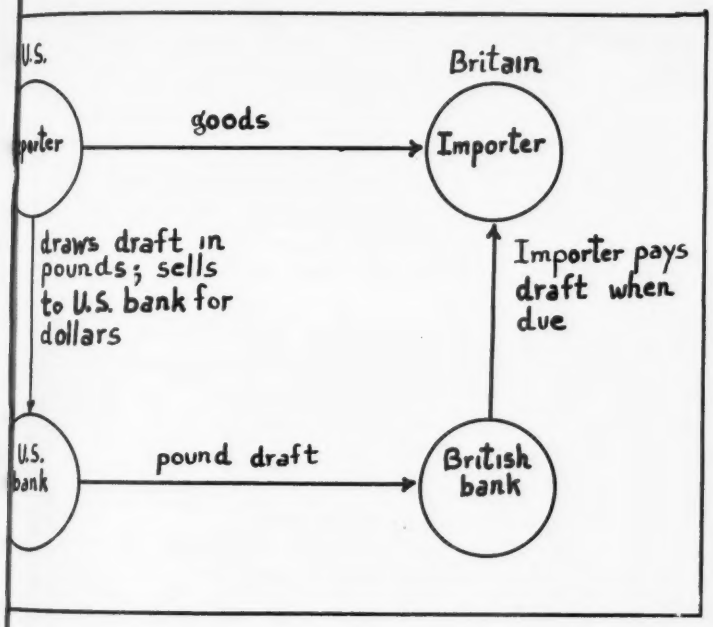
Tax policies play a large part also in determining a nation's desirability as a site of business enterprise. The really burdensome and discriminatory taxes take a variety of forms. They may be broken down broadly, however, into three classifications.

Taxes on imports are used in a great many countries. Although in some cases the intention is to protect home industries, in most capital-importing countries this can

hardly be true. The object is to discourage imports on the theory that in such fashion can be built a favorable balance of trade. The tax may be directly on the goods and raw materials brought in; it may be a tax on import papers; it may take the form of import licenses. Through the medium of delay in issuing import licenses foreign firms can be made to extend credit whether they wish to do so or not.

The internal tax structure may also be discouraging. Ordinarily national taxes in themselves are not excessive. However, discrimination between foreign and domestic enterprise is sometimes indulged in prohibitive fashion. Thus Brazil takes ten per cent of profits of non-residents. The purpose again appears legitimate from the country's viewpoint. But — in the long run, if foreign enterprise becomes fed up, more is lost than gained.

One of the most reprehensible taxes from the standpoint of the investment value of foreign enterprise is that on repatriated profits. Not only is the amount of profit which may be removed fixed by law, but that which is permitted to leave is taxed — from twelve per cent in Peru to an often used four per cent stamp tax in other countries. Such a situation requires that for a foreign investment to be worthwhile its initial return must be extremely high.



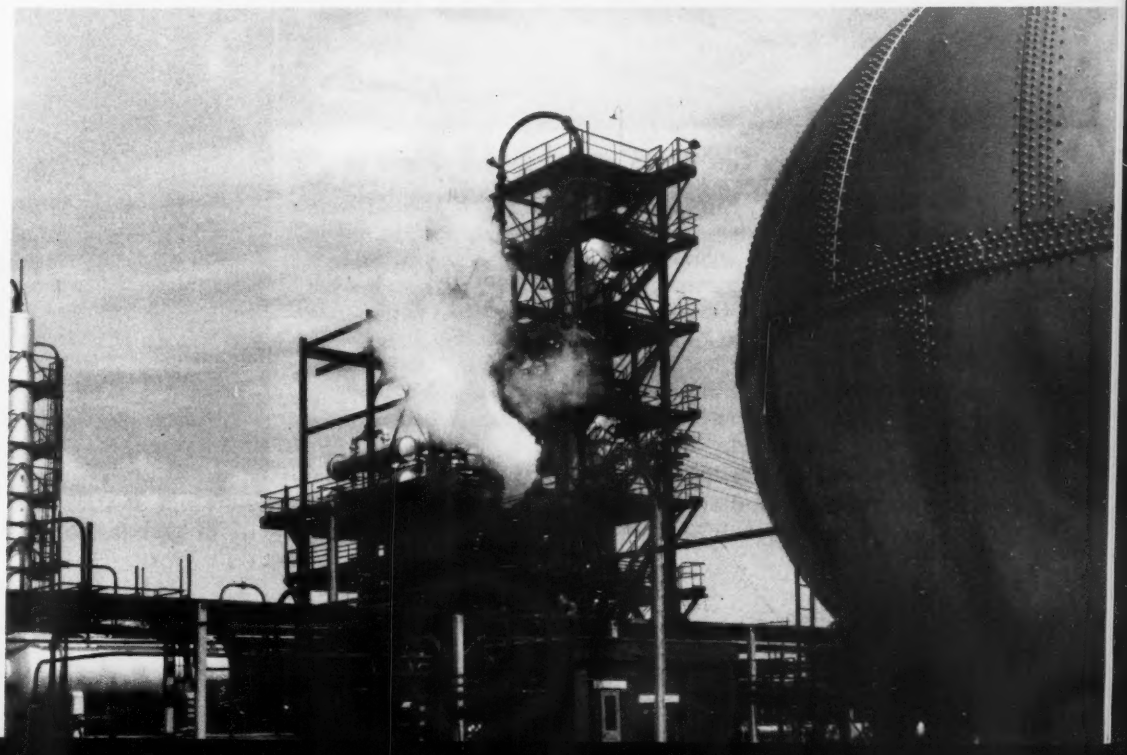
The monetary curbs, hazards, and obstacles described can be seen to have an adverse effect upon American expansion. Yet recently these difficulties have become relatively less obnoxious than those governing employment and stock ownership. The trend throughout Latin America is now toward regulations which set limits upon the percentage of foreign labor which can be used, upon the number of foreign officers and directors and upon the amount of ownership which can be extra-national. The laws here do not so much affect risk and rate of return as they tend to hamstring operations by reason of the loss of efficiency involved obeying them.

The laws of Mexico in this regard are perhaps typical. She requires that ninety per cent of labor must be Mexican. With skilled labor a rarity this condition is hard to meet. Another requirement is that fifty-one per cent of the capital of an enterprise must be owned by nationals. This is even harder to take for American capitalists. Discouragement would be almost complete if it were not for the fact that waivers of regulation are the rule rather than the exception.

That a reason exists for these laws is unquestionable. Each nation is trying to build itself up. Argument against them on a basis of right and wrong is hard to justify. What can be said is that, regardless of laudable motives, restrictions of the nature of these must have a deleterious effect upon the import of capital. It is not conceit but realism to say that labor skill and technical and administrative know-how are not as available among the people of these countries as they are among the groups sponsoring the activities affected. Managements cannot afford to put money into ventures which they are not permitted to control absolutely and direct operationally; nor can they establish any involved processes with serious restrictions placed upon the supply of skilled labor. These facts are self-evident here and are equally evident to the men who must decide whether to expand and where.

Throughout this array of concrete objections to foreign operation runs the nemesis of uncertainty as to future laws, policies and even governments. Changes in import duties, taxes, licenses, exemptions, and waivers must be foreseen and evaluated. A slight revision of any of these items quite conceivably could cut off the effective operation of a subsidiary. And looming above all these minor possibilities is that of expropriation and nationalization. Mexico's Expropriation Decree of 1938 cost investors millions of dollars

(*Continued on page 24*)



The Canadian concern which owns this equipment is a subsidiary of Standard Oil.

from studios to polymer fractions

By Dan von Recklinghausen*

Acoustics Comes into Its Own at M. I. T.

A survey shows that one hundred per cent of those machines which indulge in tobacco at M. I. T.'s Acoustics Laboratory smoke Pall Mall—they are king-sized. Of course the total consumption is only a pack a day, but the percentage looks good on paper. What do cigarettes have to do with acoustics? Well, let us start at the beginning.

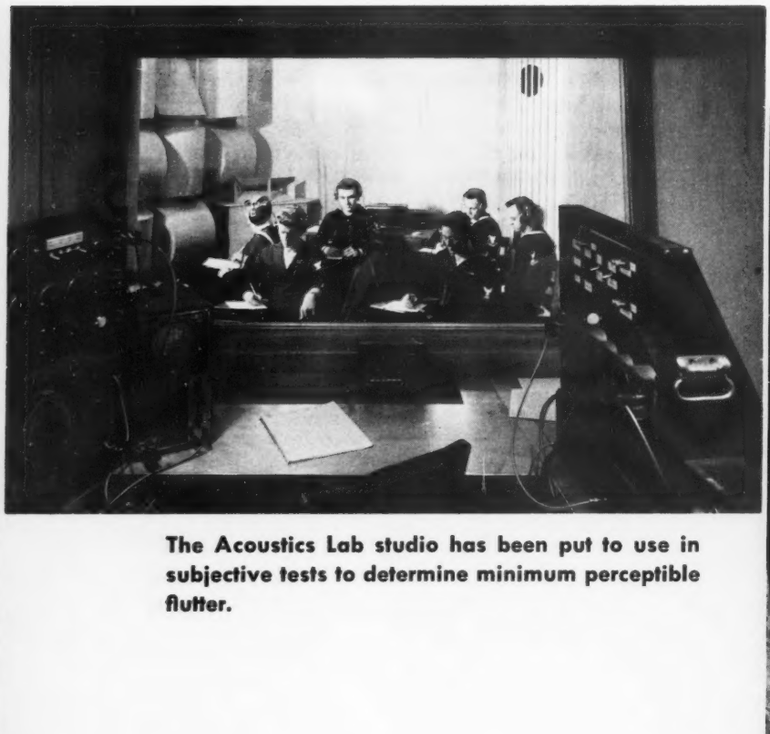
Located at present in building 20, the Acoustics Lab was originally part of the Radiation Laboratory. At its inception, in 1946, the laboratory was doing almost entirely classified work, but now, with less government work on its hands, it is pioneering in educational methods (giving ten courses in three departments) in addition to carrying on useful research. Under the joint administration of the Electrical Engineering, Physics, and Architecture departments, and sponsored primarily by the Division of Industrial Coöperation, the lab has as its purpose basic research, application, and the training of qualified men. Its research can be divided into three general fields, corresponding to the departments administering it — architectural acoustics, communication acoustics, and properties of materials and sound fields.

Everyday complaints about noises, echoes, and "paper thin walls" are much more familiar than research papers on chemical reactions catalyzed by high-frequency sound. Acoustics is now an important part of modern architecture — a concert hall must have just the right amount of reverberation; and occupants of a row house have no business being able to count the number of squabbles in the family next door. For this reason, the Architecture Department has been working with the Acoustics Lab on the study of such problems as sound transmission through panels — to produce quieter homes and factories; and studio acoustics — to give us better auditoriums and more natural-sounding radio programs.

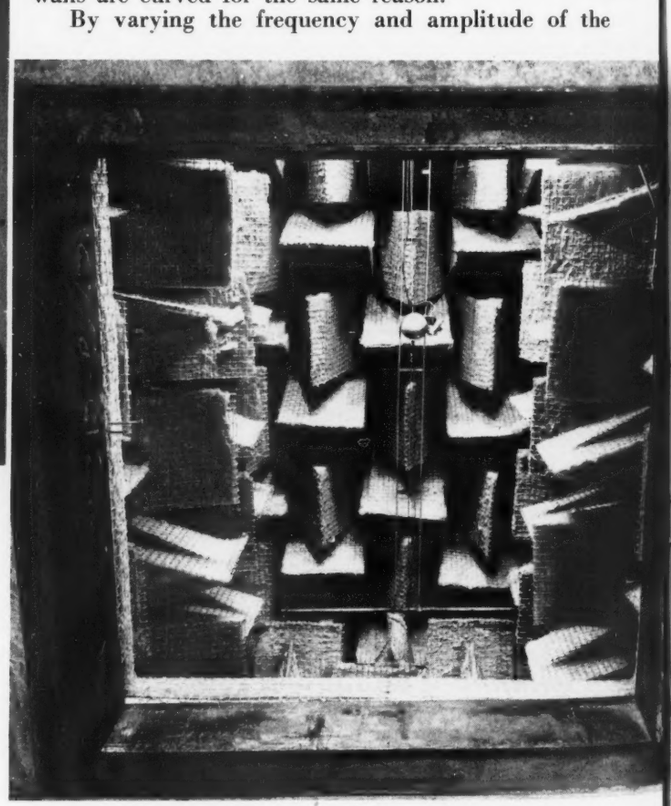
One piece of the laboratory's equipment for the study of studio acoustics is a room, specially designed as a student problem to give as much sound diffusion as possible and avoid the setting up of any standing wave pattern in the sound field. The semi-cylinders evident in the photograph may be turned to give different diffusion effects, while the ceiling is divided into cells so sloped as to break up direct echoes and the walls are curved for the same reason.

By varying the frequency and amplitude of the

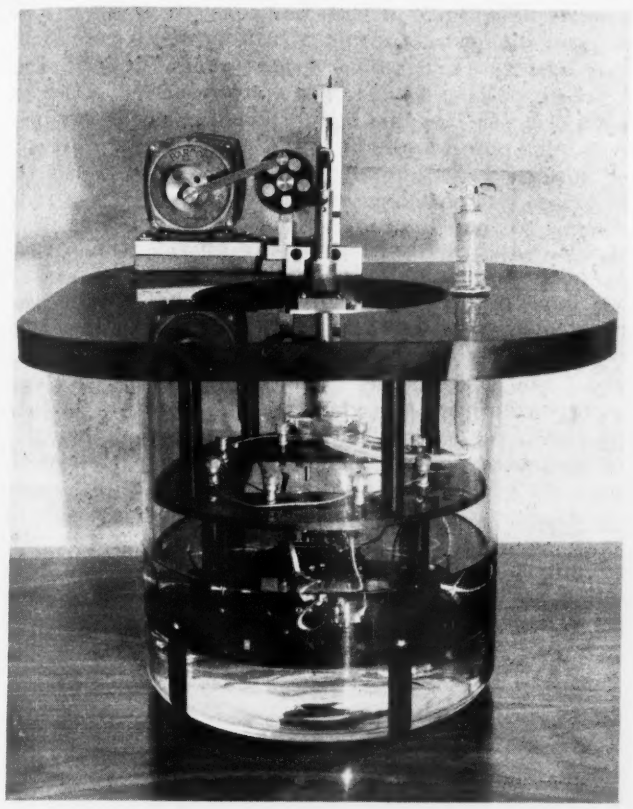
*With the kind help of Dr. Leo Beranek, Assistant Director of the Acoustics Laboratory, and Mrs. Avis Tetley, Librarian.



The Acoustics Lab studio has been put to use in subjective tests to determine minimum perceptible flutter.



This small anechoic chamber has been used to make scale studies of panel transmission characteristics.



sound source in the room, and varying the set-up of the room itself, the best conditions for a studio are being determined, along with the objective standards for measuring the quality of such a room.

To determine the sound transmission characteristics of panel materials, the laboratory has built a sound-insulated chamber with non-reflecting walls which will accommodate 8 x 8 foot panels. So as to provide complete control of the sound field in the chamber, a panel of 256 matched speakers connected in sixteen banks to sixteen amplifiers of special design is used as a sound source. By varying the phase of the input to each of the sixteen banks, a number of different types of wave fronts can be beamed at the panel under test.

The lab also owns a small scale version of the sound chamber which is being used to study the characteristics of smaller panels (2 x 2 feet) and the advisability and mechanics of applying scale studies in sound transmission.

Those Techmen who listen regularly to station WMIT are familiar with the acoustical phenomenon known as flutter, although they call it something else. When a record is played, and, through some mischance, the engineer causes the turntable to change its speed, rather funny sounds are produced. The same effect, which is noticed on movie sound tracks and wire or tape recorders, is due to mechanical frequency modulation of the audio signal. Since this effect seriously disturbs the clarity of the information being transmitted by the sound, one of the more obvious industrial applications of its study is the proper design of recording and playback equipment. A series of tests have been run to determine the minimum perceptible flutter, for the human ear, at different frequencies and amplitudes.

Much has been said about the mathematical and electrical theory involved in the transmission of information and a great deal of research is being done on it; however, most information transmitted must be converted to sound to effect our understanding of it.

The properties of materials are often influenced when treated with ultrasound from the Lab's crystal generator.

The test studio presents an interesting maze for unwanted reverberations.

Therefore, a study of the most efficient methods of transmitting information by sound has been undertaken at the Acoustics Lab. How much of each of the speech components, for example, is necessary for understanding of the information contained in the speech — to what extent speech can be clipped or narrowed in bandwidth and still contain the transmitted data.

Although it is a long stretch from speech transmission to damping sound from heavy machinery, the field is still in the province of the laboratory. One important matter under study has been the elastic and dissipative properties of various types of rubber. So that experiments may be as accurate as possible, methods have been developed for accurate preparation of these substances. The lab can carry out many of the processes involved in preparing rubber to keep to a minimum the error due to variation in composition of commercial products. An apparatus has been constructed to fractionate large samples of polymers in order to provide accurately known ranges of polymers. From the research being done along this line, a new theory relating the visco-elastic properties of rubber to the degree of polymerization and vulcanization is being developed. Studies are also going on on the sound effects in textiles.

It would seem entirely wrong if the Acoustics Lab were not to do some research on high-frequency, high-amplitude sound. For work with ultrasound, the lab has built a crystal ultrasonic generator. Power is fed to a network of crystals which produce an intense sound

(*Continued on page 30*)

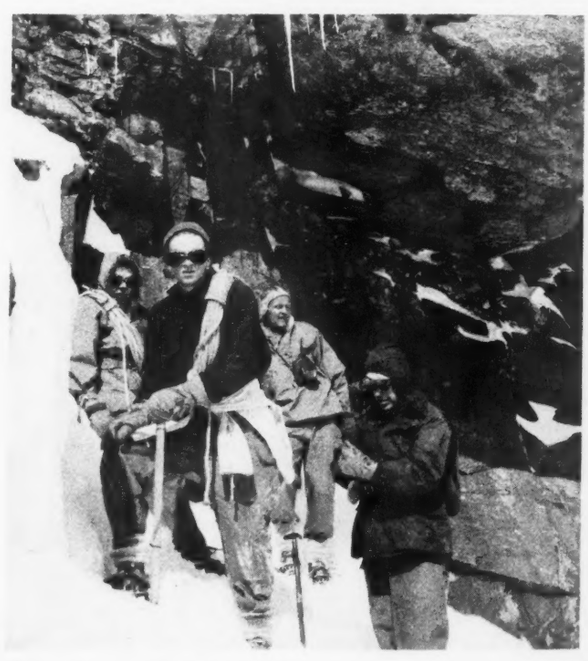
rocks, ropes, and snow

By Paul Westheimer, '52

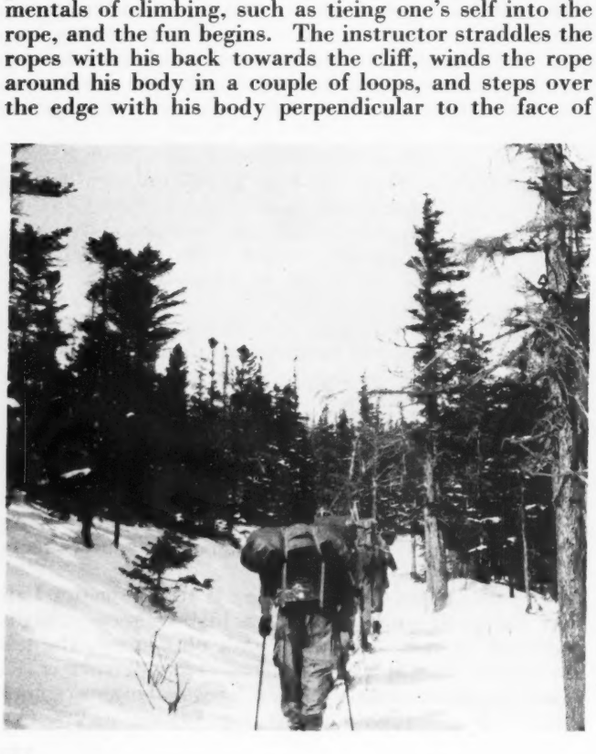
"Ca-oo-wah!" Wherever one hears this hearty, carefree call ringing across the countryside, from the Blue Hills to the Adirondacks, he can be sure of finding a bunch of spirited Outing Club members temporarily leaving behind the cares of their studies and congested city life.

The M. I. T. Outing Club is a branch of the Inter-Collegiate Outing Club Association, a loosely-knit organization of Eastern college outing clubs. M. I. T. O. C., as Tech's outing club is commonly referred to, had its start in 1933 as the Ski Runners' Association. However, the demand from its members for activities extending beyond the ski season led to the formation of an outing club in 1935. Since then, M. I. T. O. C. has flourished until, today, it comprises some three hundred members active in skiing, hiking, rock-climbing, bicycling, mountaineering, horseback-riding, swimming, and square dancing. Future plans call for greater expansion, including the building of a cabin and the purchase of a station wagon or truck. So much for historical details. Let us look at some of the activities which make the Outing Club popular.

So you have never been rock-climbing? Let us go along on one of the M. I. T. O. C. climbing trips. After a group of climbers from Tech and, probably, some girls' school has gathered at Park Street subway station, it proceeds to Quincy Quarries or Rattlesnake Cliffs in the Blue Hills. Your first glimpse at the cliff makes you wonder why you came along. Once you reach, by a rather circuitous route, the top of the rock-pile, the instructor demonstrates some of the fundamentals of climbing, such as tieing one's self into the rope, and the fun begins. The instructor straddles the ropes with his back towards the cliff, winds the rope around his body in a couple of loops, and steps over the edge with his body perpendicular to the face of the cliff. In a series of leaps and bounds, he reaches the bottom, smilingly looks up and asks, "Next?" You look at him skeptically, but on account of the urging of the rest of the gang you decide to give it a try, hoping that the rocks on the bottom are not too hard. You make the appropriate turns of the rope and gingerly step over the edge, heart in mouth. At first you clutch the rope in a frenzied grip, but, amazingly, you just hang there. Not until you almost let go do you start gently moving down. Gradually, as tenseness disappears, you start jumping against the side of the cliff and paying out several feet of rope at a bound; but not for long, for it soon becomes apparent that work done against friction is translated to heat at the seat of your pants. Once you finally touch ground, you are more than eager to try your hand at climbing again.



Time out to watch the birdie



Climbing Mount Washington

This time you climb up the cliff. You tie yourself on the end of the rope and start to climb while someone at the top of the cliff takes up the slack in the rope, the other end of which is securely fastened on a tree, rock, or piton. The first part of the climb is fairly easy. As you get about halfway up the cliff you see a crack in the rock which looks like a made-to-order hand hold. As you eagerly reach for it the instructor informs you that obvious ways to cling are ruled out. Perplexedly you contemplate the smooth rock above as someone tells you to put your left foot three inches above and to the right of your left shoulder. You know darn well that there is not room on that little ledge for your chin and your foot. Another fellow thinks he has better advice: "Put your feet where your hands are and step on them." Finally you find a crack wide enough to get half a fingernail in and pull yourself up. When you eventually reach the top you exhaustedly look down and exclaim "Did I climb that?" However, as you graduate to more interesting climbs with picturesque names such as, Fat Man's Folly, The Overhanging Overhang and Cape Eternity you laugh at your earlier difficulties. Incidentally, in the rock-climber's vocabulary "interesting" refers to climbs which range from difficult to impossible.

However, if you do not feel rugged enough to take up rock-climbing, chances are that you will find something that will interest you from among M. I. T. O. C.'s many activities. Take, for instance, skiing. In the winter the various outing clubs in the Boston area get together and sponsor skiing trips to places such as Laconia, New Hampshire, in chartered buses at surprisingly low cost. It is possible to go on a ski trip for about $5.00 including all expenses. A large part of the enjoyment on these trips comes while traveling to and from the ski areas. Usually someone brings a guitar or similar instrument and there are jovial songfests in the pauses between bull-sessions. For the more advanced skier there are also trips to Stowe and Tuckerman's Ravine, with a wide variety of open slope and trail skiing.

Guess it's time to eat.

Some view! It's probably worth all the climbing

An activity which seems to be rapidly increasing in popularity is spelunking or cave exploring. There have been several trips to Eldon's Cave in Massachusetts near the New York border and a trip to some interesting caves in Schoharie County, New York. On this there were several memorable events — for instance, the time a spelunker left a rope in the depths of one of the caves. Retrieving it involved crawling through a subterranean stream. By the time the poor guy came up he bore a striking resemblance to a shaggy poodle which had just been pulled out of a swamp.

Another interesting type of trip which the outing club sponsors occasionally is a fox and hounds chase. One group of members hikes through the woods scattering small bits of paper behind it while other groups try to follow its trail. The trail meanders all over the woods, often doubling back or coming to dead ends by the edge of some swamp or lake. There is nothing as discouraging as having to double back a mile or so

Will somebody tell us whether they're coming or going?

through thick underbrush. At a fox and hounds chase last circus, one bright member of a local outing club decided to be different. The trail ended at the edge of a lake. However, this particular outing clubber saw a dog walking along the edge of the lake, which was still frozen, and thought she could do it also. For the rest of the chase one member had rolled up pants and red flannels on.

However, the high spot of the Outing Club year is College Week. This is a week's get-together in the Adirondacks of members of the various Eastern I.O.C.A. clubs. During this week there is one happy family of about one hundred and fifty outing clubbers assembled in the wilds of the Adirondacks to have the time of their lives. As you pull into the parking lot by the Adirondack Loj you are rather startled by the cosmopolitan array of cars that is assembled there. At least ten states are represented. You are glad to have reached your destination after having ridden for several hundred miles with six people in the car. Slowly you pile out, gradually straightening the kinks in your spine, slip into your pack, and start down the trail marked Lake Colden. The first couple of miles are not bad, the exercise feels good and the trail is nice and wide and not steep. Gradually, however, the trail begins to steepen and become narrower. Soon you are scrambling over rocks and between trees and occasionally get a glimpse of the beautiful Adirondack landscape. After the third mile you enter the famous "misery mile." You cross several streams by balancing across on logs when suddenly you see a huge boulder looming ahead right in the trail. As you perplexedly get closer you see a little ladder going up one side of the boulder and down the other side, through the "lemon squeezer," a passage between two boulders just wide enough for a man with pack to squeeze through if he has not had too much lunch. The rest of the trail is not bad except for one bridge of floating logs which has a nasty habit of sinking a couple of inches below the surface under your weight. Finally you reach one of the lean-to's around the Lake Colden area just in time to join in a square dance to the music of a couple of guitars and an amateur caller. (This is, of course, after you have prepared supper over a fire or Coleman stove.) When the group eventually tires out, everyone gathers around a roaring campfire for singing and talking. The congeniality of this group around the fire is perfect. Finally the embers die out and by midnight nearly everyone has sacked in. Those who do not fit in the log lean-to's crawl into improvised tents made of shelter halves or ponchos. You are lulled to sleep almost instantly by the gurgling of the nearby mountain stream. Sooner than you think possible, it is daybreak and you extricate yourself from your sleeping bag, wash yourself with the invigoratingly cold mountain water and prepare breakfast. It is amazing how outdoor life can whet one's appetite. After clearing away the dishes and packing a light lunch you start on the day's hike with a group of about four. One of the most interesting hikes in that area is the one to the top of Mount Marcy, the highest peak in New York State. The trail, especially near the end, is much like "misery mile," but the magnificent view from the peak makes you forget completely about your aching muscles. On these hikes there is seldom a dull moment. Quite frequently someone loses his balance on one of the log bridges and neatly slides into the water for a refreshing involuntary swim. Hiking and square dancing, however, are not the only activities at College Week. There is boating on the lakes and some of the more hardy characters do some climbing on cliffs in the vicinity. Everyone has a great time. About the only objection to College Week is that it is too short.

You are probably wondering by now what makes the outing club tick. Most of the work is done by a nucleus of about ten council members. The council is a group of members who have passed a list of quite rigorous requirements sufficient to prove that they are reasonably proficient in the various aspects of outing clubbing. This council has weekly meetings in the M. I. T. O. C. office in Building 18 to plan for future activities. Most of the one day trips are planned a week in advance while arrangements for longer trips are usually made several weeks in advance. You can depend on the council to plan a full and varied program for M. I. T. O. C. There will never be a dull moment among outing clubbers while there are some woods and omuntains available.

the lost trait

By Dan R. Test, '50

Once upon a time in a faraway land lived an Engineer. He was a famous engineer — broad of mind and sinewy of brain. His fame had spread to distant corners of the earth. He had engineered the longest bridge, the highest building, the deepest mine in all the world. The other things that he did are too numerous to relate. Wise men from all corners of the earth journeyed to the home of the Engineer to read his notes, to watch him integrate around a closed path, and to touch his slide rule (correct to five significant figures).

In spite of his riches, power, and pelf, the Engineer was vaguely unhappy. So one morning, in his usual scientific logical way, the Engineer sat down at his

functional desk to list in an orderly manner (with due regard to algebraic sign) his earthly accomplishments. Then he plotted Happiness (in British joyful units) as a function of Accomplishments. The curve was concave downward! Checking and rechecking by independent methods confirmed a bewildering fact: as accomplishments increased, happiness decreased — exponentially.

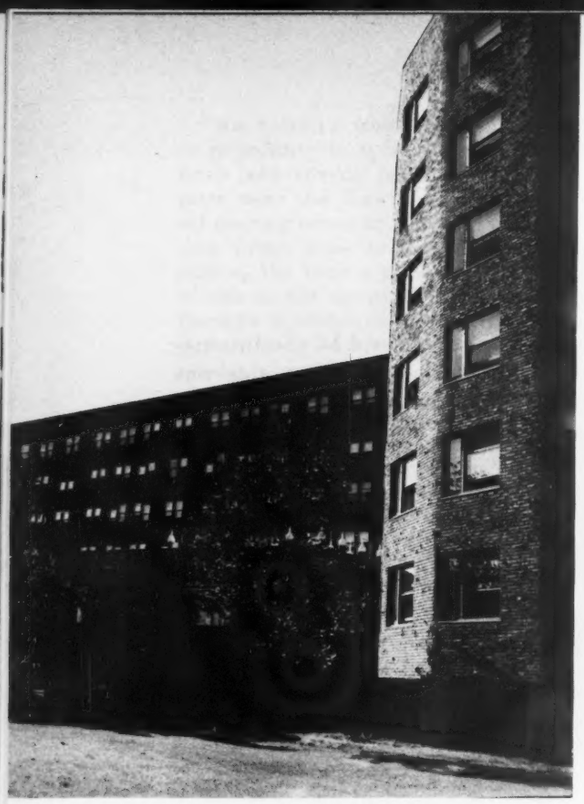
The Engineer was despondent. He had graduated from the best of schools. Surely his calculations were correct . . . but he must have overlooked something. Thumbing through tomes of notes, he happened upon a college math assignment. Of course — he had been a fool. X is an *independent* variable. Perhaps Accomplishments were a function of a more basic quantity such as . . . *time!* Aha!

Now the Engineer was extremely sad. The longer he might live, the unhappier he would become. The graph was based on the normal superior type. Certainly he was superior. Perhaps he did not possess all the traits of a Normal Man as defined by the International Association of Psychoanalysts. But, this was unthinkable. The Engineer distinctly recalled that all traits had been included in the last accountant's report (less allowance for depreciation). Perhaps he had lost a trait!

He hastened to his vault. Brushing aside servomechanisms and an old Carnot cycle, the Engineer jerked open his file and began to check his traits. Anxiety had deprived him of his usual cool logic. The scientific method was forgotten as he haphazardly opened the manila folders containing his traits. Yes, his Honesty was still there. Patience and Perseverance were still in their crisp blue envelopes. He checked his Memory (listed under Recall, Powers of). He had not lost that. Individuality and Integrity were still on file, side by side. Humility was there, although it had become slightly warped. The Engineer made a mental note to design a constant-temperature vault. Even Courage and Adaptability had begun to wither slightly because of the poor air, no doubt. The Engineer breathed a sigh of relief as he checked Intelligence, Superior (cf. I.Q.). Thank God that had not been lost!

The counting of his many traits had soothed the Engineer somewhat. He began at A (Ambition had not moved from its customary place) to check systematically through the complete file. His mind leaped back to the graph. The sharply increasing negative slope had indicated the loss of an important trait or perhaps (throwing scientific caution to the winds) an *extremely* important trait. Thumbing through E, F, F_a, G, and H, he came upon Humor, Sense of. The folder was empty. . . .

MORAL: *Too close an approximation is hard on one's stomach.*

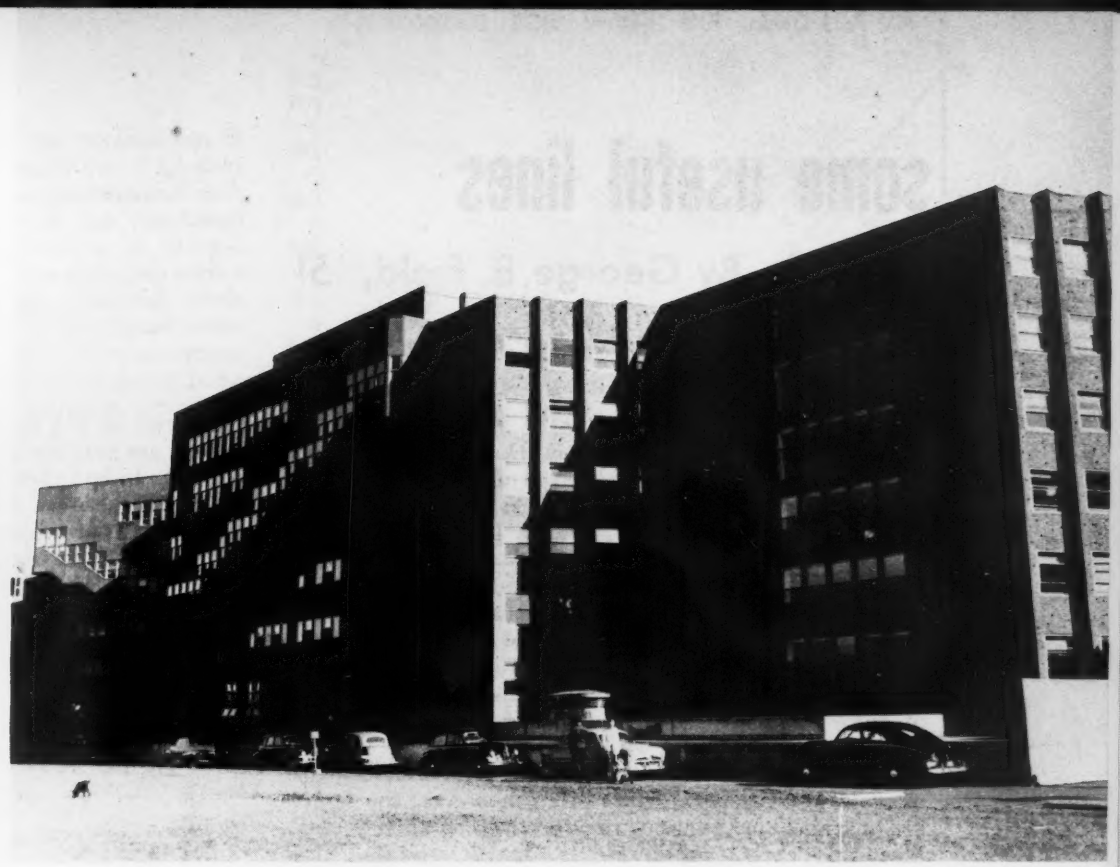


Eighty-five per cent of the rooms in Tech's New Dormitory have river exposure.

The Duplicate Bridge Tournament meets every Saturday in the Dorm's dining hall.

The New

The illumination for the dining hall is furnished by lights which are seen on its roof.

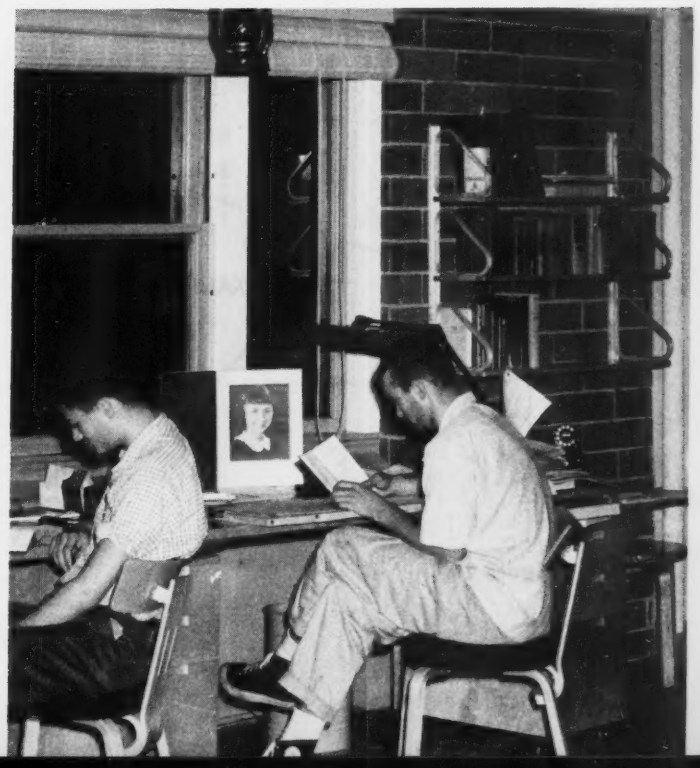


The entrance to the New Dorms is, believe it or not, on the side of the building away from the Drive.

Dormitory

Here's a place to relax after a meal, with cigarettes, coffee and talk.

Rooms may be functional, but before long students give them that "lived in" look.



some useful lines

By George B. Field, '51

An Introduction to Nomographs

A nomogram — what is that? Sure, we know, it is something they talk about in D 31, an advanced Graphics course. Well, take my word for it, a nomogram is not complicated, nor is it useless. Put simply, a nomogram is a graph or diagram. Now, most graphs are made with the idea of depicting a relationship; nomograms are made to solve formulas — to compute answers graphically from given data. To be sure, a regular graph does this, in that one can read a value of y given a value of x, but nomograms make a specialty of this process. Further, nomograms make easy work of formulas having three or more variables, which present grave problems with a Cartesian chart.

The nomogram, like other graphs, is an arrangement of scales on a paper. Most often, however, the scales are parallel or skewed rather than perpendicular. Naturally, each scale represents a single variable. One reads the nomogram by finding points on the two scales representing the given variables, and putting a straightedge through the two points. The straightedge, by a sort of predestination, just *has* to pass through some point on the third scale, which represents the unknown variable. Thus, the intersection of the straightedge and the third scale is the answer. That is, if the nomogram was made correctly. We are fairly sure that Fig. 1, which solves $2x + y = 3z$ has been correctly made, so you may look at it as an example of what we have been talking about. Note how the straightedge *SE* cuts x at 4 and y at 7, and then z at 5, as it should.

It is obvious that making nomograms presents two problems: making scales and arranging them. The solutions of these problems are interdependent; the properties of the scales and their separations, for instance, are mathematically related. Moreover, you do not have to find these relations for each new nomogram, for this is the work of previous nomographers. Various geometrical arrangements have been evolved which are suited particularly to certain types of formulas, such as those involving addition, proportions, and trigonometry. We shall take up a few of the more useful forms. First, however, let us take a look at scale construction.

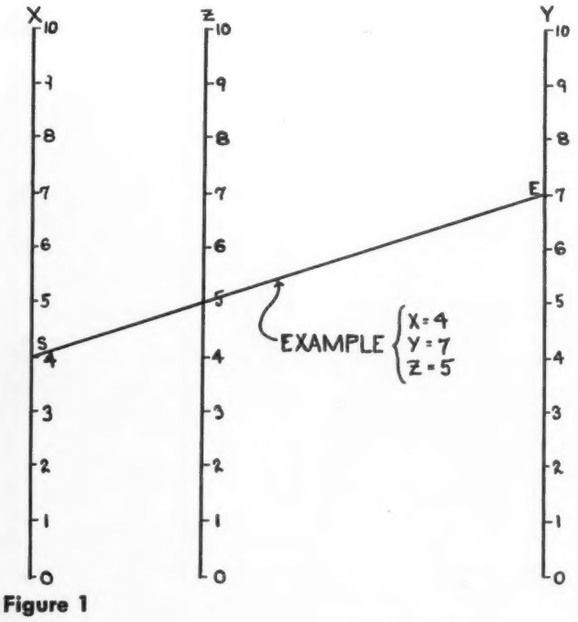


Figure 1

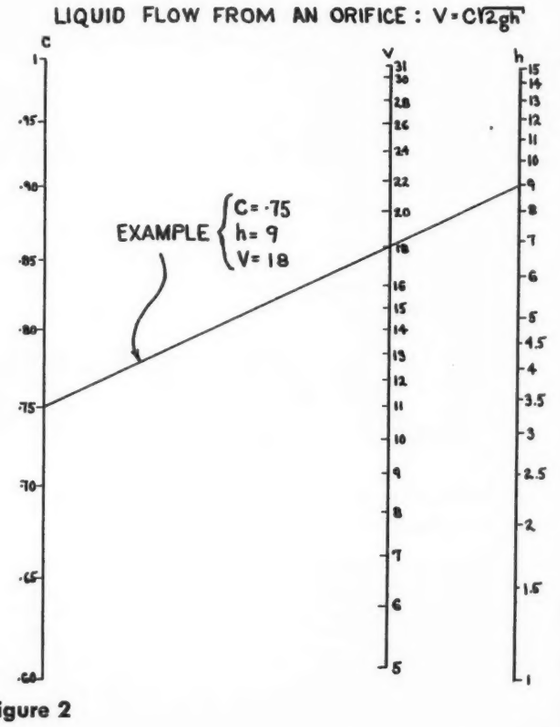


Figure 2

If you start to make a scale to represent t^2, say, where t is just some old variable, you will soon discover that what gives meaning to the scale is laying off distances according to t^2, but then to label the graduations according to t. In other words, the scale tells you something, for each point has both a label and a distance. Such a scale is called a *functional scale*, since we can lay off distances according to any function of t, not just its square. Hence, $f(t)$ might be log t, $\sqrt{t^3 + 1}$, or $t/6$. On the functional scale distances are proportional to some function of the labels on the graduations. The constant of proportionality, for some reason or other, is called the *scale modulus*, m. Then if s_t is distance on a scale of $f(t)$, $s_t = m_t f(t)$.

Thus, *to make a scale*, we first tabulate t over some range, and find corresponding values for $f(t)$. Then, having established a modulus we know will give us a

scale of usable length, we mark off the graduations in accordance with the simple equation above. All that remains to be done is to label the graduations with values of t. An excellent example of the functional scale is found in the slide rule scale, where $s_t = 10 \log t$, measured in inches. It is plain that the slide rule scale's utility lies in the fact that labels are observed, while distances are added. With the idea of functional scales in mind, it is easy to construct the scales of a nomogram.

As we said before, *arranging the scales* depends on the type of formula to be solved. Addition, of course, is simplest. Suppose you want to solve

$$f_1(x) + f_2(y) = f_3(z),$$

which might be

$$3x^2 + 5y^3 = z$$

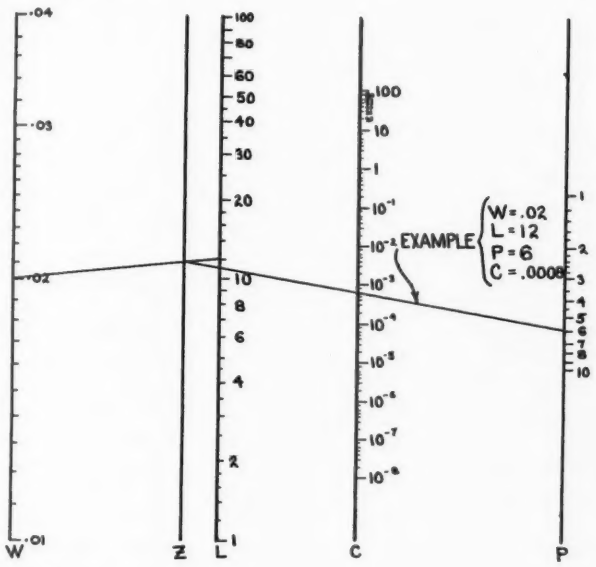


Figure 3

We can construct the x and y scales parallel with arbitrary separation following the methods of scale construction outlined above. We must make sure that the moduli chosen give convenient scale lengths. Once we have the x and y scales, the z scale must be located to satisfy the relation: $\frac{m_x}{m_y} = \frac{a}{b}$. Furthermore, the modulus of z, m_z, must be chosen so that $m_z = \frac{m_x\, m_y}{m_x + m_y}$ In order to calibrate the z scale, first find a reference point by putting a straightedge through some x and y, noting the intersection, and calculating its value from the formula. The z scale is then easily calibrated, remembering that $s_z = m_z f_3(z)$.

Taking a page from Mannheim's book, we reflect that numbers can be multiplied by adding their logs. Hence, multiplying factors which are functions involves merely taking logs and treating the problem as an addition. Suppose that $v = C\sqrt{2gh}$, which it does, if we are talking about efflux velocity from height h. Then

$$\log v = \log C + \tfrac{1}{2} \log 2gh.$$

Presto! Addition! Whipping out the rule book, it is easy to make a nomogram for this formula, as demonstrated by Fig. 2. To eliminate dogwork (the ultimate goal of nomography) you should use a slide rule scale for making log scales. In Fig. 2, for instance, the

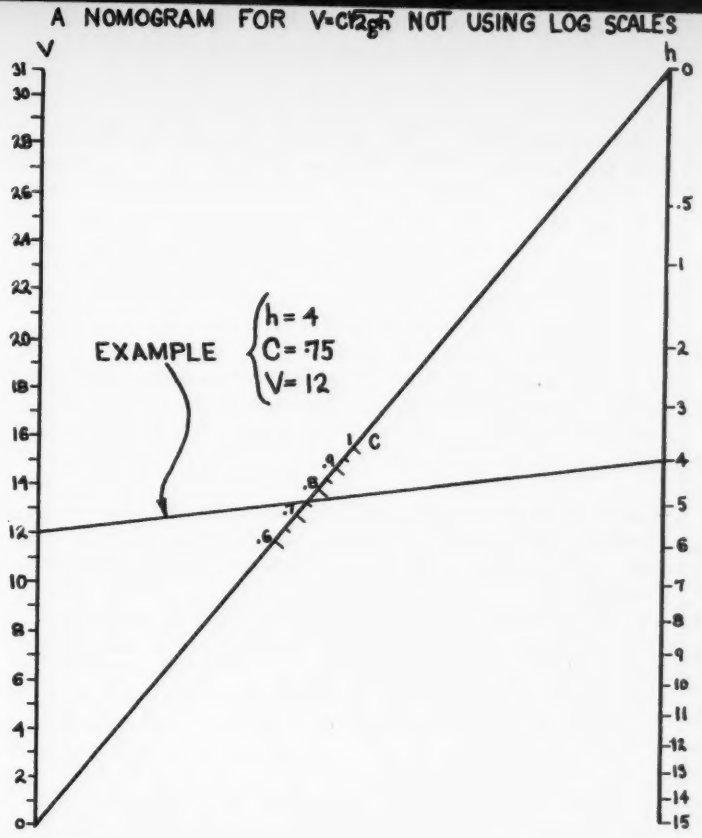


Figure 4

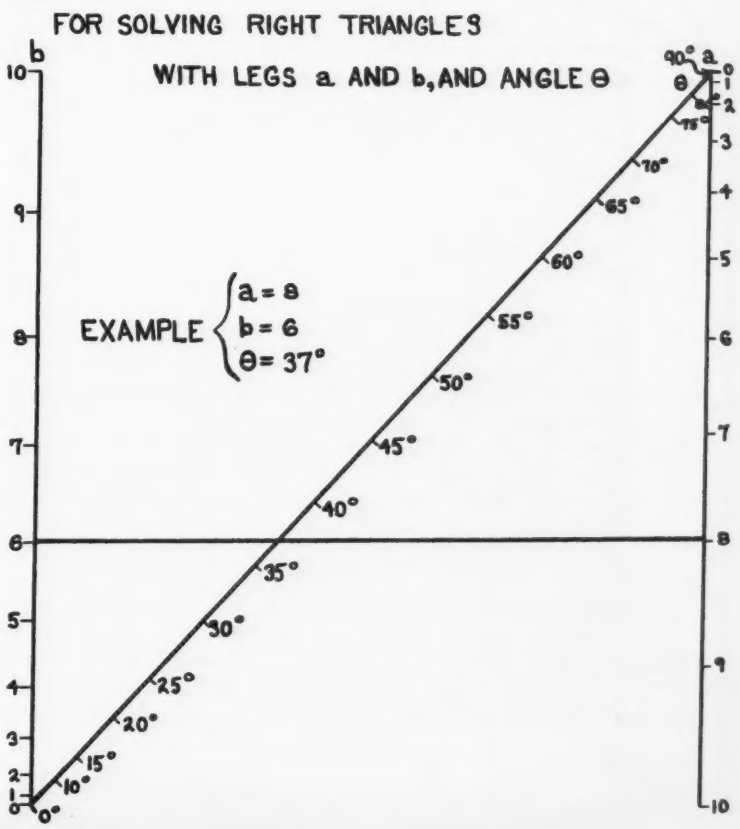
C scale is readily made by touching the 0.6 on the chart to the 6 on the slide rule, drawing a line from the 1 to the 10, and projecting other points parallel to this line.

Luckily enough, the number of variables which can be added (or multiplied) by the nomogram is unlimited, simply because each answer can be used in a new addition. For instance, suppose we have

$$f_1(u) + f_2(v) + f_3(x) + f_4(y) = f_5(z).$$

This seems stupendous, but it is readily reduced to a trivial problem. Treating f_1 and f_2 in the fashion described above, we get their sum — call it f_2' — which appears on a sort of artificial f_2' scale created for a

Figure 5



special purpose. This special purpose is to be added to f_3. In other words, since we cannot add f_1, f_2, and f_3 all at once, we add the first two and then add the sum to the third. So we carry on the process, getting f'_3, f'_4 and so forth, ending up with a reading on the f_5 scale. Note: it is unnecessary to label auxiliary scales. We are not interested in numerical values of the auxiliary variables, but only in their representation as points which can be used in further operations.

It is now possible to solve a problem of four variables; the solution is in Fig. 3. Pictured there is

$$C = \frac{W^2 L^3}{2^4 P^2}$$

a civil engineering formula giving a correction for sag when a steel tape of running weight, W, and length, L, is pulled with a force, P. We put the formula into order:

$$\log C = \log 1/24 + 2 \log W + 3 \log L - 2 \log P.$$

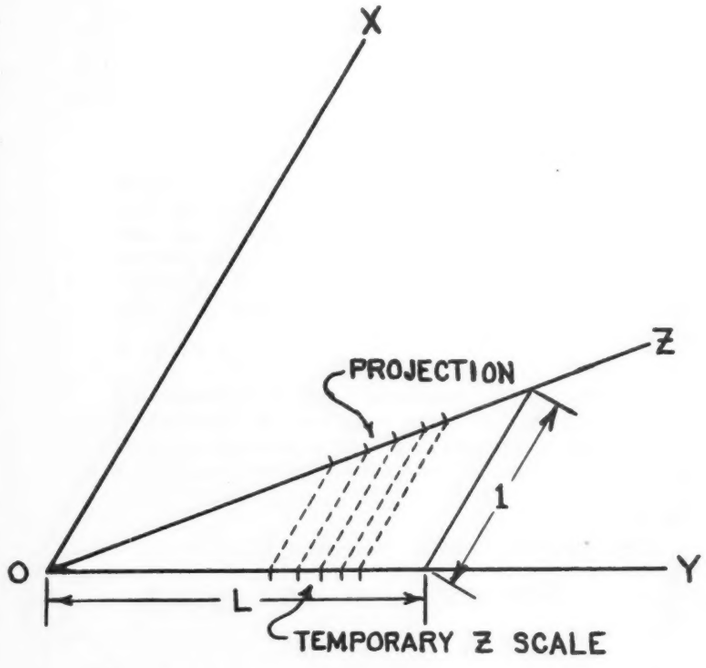


Figure 6

Now, let an auxiliary variable Z equal the product in the numerator. Then,

$$\log Z = 2 \log W + 3 \log L.$$

This is easily found by regular methods; subtracting the 2 log P means only that we calibrate the P scale downward, as the scale equation tells us that distances are negative. It is important to note that the only effect of constant factors, such as 1/24, is to raise or lower one of the scales vertically. Hence it is automatically taken care of when we find a trial point on the Z scale. (Although the auxiliary Z scale remains uncalibrated, a trial point on it is necessary for use in finding a trial point on the C scale. Thus the constant finally makes its presence felt in locating the C scale.)

If you are allergic to log scales in any form, raw or prepared, there is another way to multiply nomographically — by using the so-called Z chart. The chart is shaped like a Z, since the product scale is parallel to

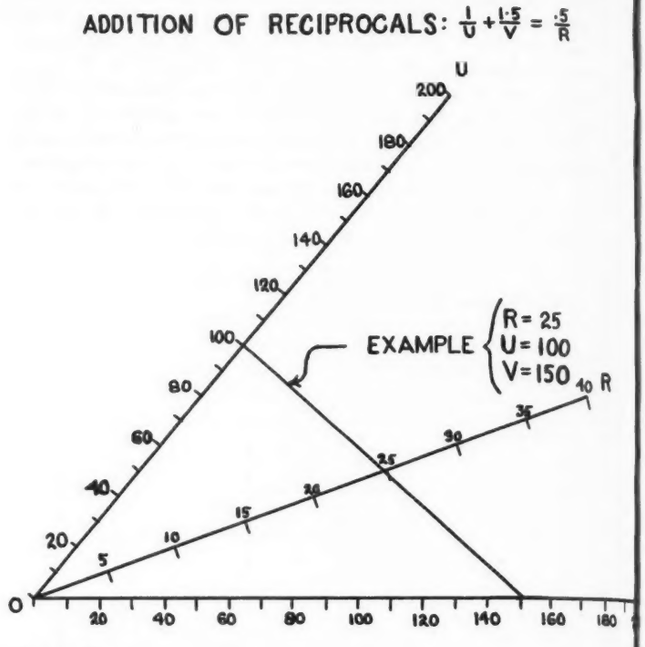


Figure 7

one of the factor scales; the other factor scale cuts them at an angle. By way of explanation, let us apply the Z chart to the same multiplication we did before by logs — $v = C\sqrt{2gh}$. We are multiplying functions of C and h. Hence, we draw the v (the product) scale parallel to the h (a factor) scale. Again we choose convenient moduli, taking care this time to lay off the h scale in a downward direction. The C (a factor) scale is then drawn between the origins, forming a diagonal of length to be called K. All this is shown in Fig. 4. Quite unexpectedly, the equation for calibrating the C scale is: $S_C = \dfrac{K}{\frac{m_v}{m_h} f(C) + 1}$, where s_C is measured from the h origin. It is obvious that this is far from being a direct proportion; the formula is born of the peculiar geometry of the thing. It all means that "plugging in" and "making a little table" are unavoidable; there are no shortcuts. Such labors are rewarded by a more accurate chart.

By virtue of its peculiar form, the Z chart can be made easily to solve equations of the type:

$$f_1(x) + f_2(y) = \frac{f_1(x)}{f_3(z)}$$

Necessary conditions in this case are that $m_x = m_y$ and that $m_z = K$, surely a very modest requirement. To be truthful, we must admit that equations of such a type are somewhat rare. Here is at least one, though. Consider a right triangle of sides a, b, and c, the hypotenuse. The angle between a and c is θ. Then

$$a^2 + b^2 = c^2 = \frac{a^2}{\cos^2 \theta}.$$

The chart of this equation takes very little time to construct; it is shown in Fig. 5. Really, such a chart solves the triangle, since it shows the relations between two sides and an angle.

Last but not least in our little file of useful forms is

(*Continued on page 26*)

sixty second sizzling

By Samuel A. Goldblith

The Radar Oven Makes Good

The cavity magnetron tube, which is the basis of radar, generates microwaves which penetrate into foodstuffs and set up localized excitation of the molecules of food. Result: complete internal heating of the entire mass of food at a very high rate.

Commercial equipment for radar cooking, operating at 2450 megacycles, is on the market. Hotels, restaurants, and the like use them; at present, though, radar cooking is limited to quantities less than two pounds or so. This is because of limited penetrating power of the high frequency waves. A "Radarange" (Fig. 1) has been tested in the Food Technology labs, with surprising results. A typical experiment is described below.

Commercially ground hamburg was purchased on the open market and seasoned with a small amount of salt and pepper. Four small, flat, round hamburg patties weighing 75 grams each were placed in 600 ml. glass beakers and cooked in the radar oven for one minute. From the same batch of ground raw meat four more hamburg patties of the same size were made and fried in a skillet in the conventional fashion on a gas plate. The hamburg patties required only one minute heating on the radar oven, whereas the gas cooked samples required from five to six minutes to arrive at what was considered a comparably cooked condition. The radar cooked patties were heated through the meat evenly and as a result there were no crusts at the surface of the patties. The radar cooked patties were also better done in the interior than is the case with grilled patties.

Similar experiments were also conducted with haddock and with frankforts. In the case of the haddock steaks, the cooking time required on the radar range was 40 seconds compared with about 12 minutes required in a 500° F. gas oven. Both the haddock steaks and the frankforts lacked the typical crisp crust found when conventional methods of cooking are used. In all the experiments the taste was the same for both the radar and the conventional methods of cooking.

Due to the fact that these radar emanations heat the food equally throughout and not from the outside in, as with conventional means, food may be heated extremely rapidly. For instance, the temperature of food in the oven may be raised from −10° F. to 140° F. in two minutes or less, depending on a number of factors such as weight, thickness, and the type of material.

The significant difference between food products cooked in radar ovens and those cooked by conventional methods is that in the former case, no crust or carbonized surface is formed because the heating is uniform throughout the product. This effect is especially important in pastry and cake. Commercial packaged cake mixes (Devil's Food, gingerbread, and white cake mixes) were also cooked by radar and in a gas oven. The radar-baked cakes were cooked evenly throughout and differed from the oven-baked cakes mainly in that they lacked a crust. Hence the radar oven is recommended for cakes that are normally to be covered with whipped cream or a frosting. A crust, however, may be obtained by exposing the upper surface of a radar-baked cake to the heat radiations of a fine-wire heating element for one to one and one-half minutes. The rapidity of radar heating may be realized when one considers that for standard cake mixes baked in a gas oven for thirty minutes, the time may be cut in the radar oven to one minute.

In most instances the vitamin retention of the two methods of cooking is about equal. In hamburg cooked on a griddle some of the thiamine and riboflavin content of the patties is lost by the splattering of the juices. Such losses would not occur in hamburg patties if the meat were cooked within the rolls, as is customary, on the radar range. The magnitude of the loss of thiamine in the case of various types of cake mixes was found to be consistently greater for conventional oven baking than by the radar method.

However, the interval of cooking in the radar oven has a considerable influence over the decreases in thiamine experienced. Overcooking for as brief a period as thirty seconds may almost double the loss. An additional period of overcooking of such slight duration may also have a severe effect on the appearance and edibility of the product. Fortunately an accurate means of automatic precision timing for terminating the exposure period is built into the radar equipment used.

Another potentiality which has been explored is the application of radar energy to the blanching of vegetables. (Blanching is the treatment of vegetables by heat prior to freezing or canning for the purpose of inactivation of enzymes, reducing the turgidity of the food for better fill of the package, etc.)

(*Continued on page 32*)

tech engineering news

Professional Journal of the Undergraduates of the
Massachusetts Institute of Technology

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from the editor's notebook

From the horse's mouth . . .

A copy of the *Chemical and Engineering News* received early in October contained an article of interest to all those Techmen who feel that they are slated for top positions in industry. The article reported the results of a survey of chemical industrial research leaders, which, unlike most other surveys, covered only the top ten per cent. A few facts of interest uncovered by the poll include data to the effect that a majority of the leaders worked their way through college to some extent, all the while engaging in a wide variety of extracurricular activities; that sixty-four percent worked for only two companies; that patents and publications were not too prevalent in the group.

Although the average time it took the researchers polled to double their salaries was only six years, *Chemical and Engineering News* points out that they grew up with industrial research, an opportunity lacking to today's graduates. A few of the personal opinions of the men queried fit the expected "advice to youth," but because of their source, ought to be given special attention. It was felt that, taking honesty and training for granted, a young man who wished to get ahead should work hard, learn how to get along with others, and to express himself well in both speech and writing. Many of those responding felt that they should have taken courses in business management or economics. A large percentage was found to work frequently outside of office hours on business.

If this data discourages anybody, let him be of good cheer. Eighty-two per cent felt that the standing of their school was a help in their careers.

T. E. N. presents . . .

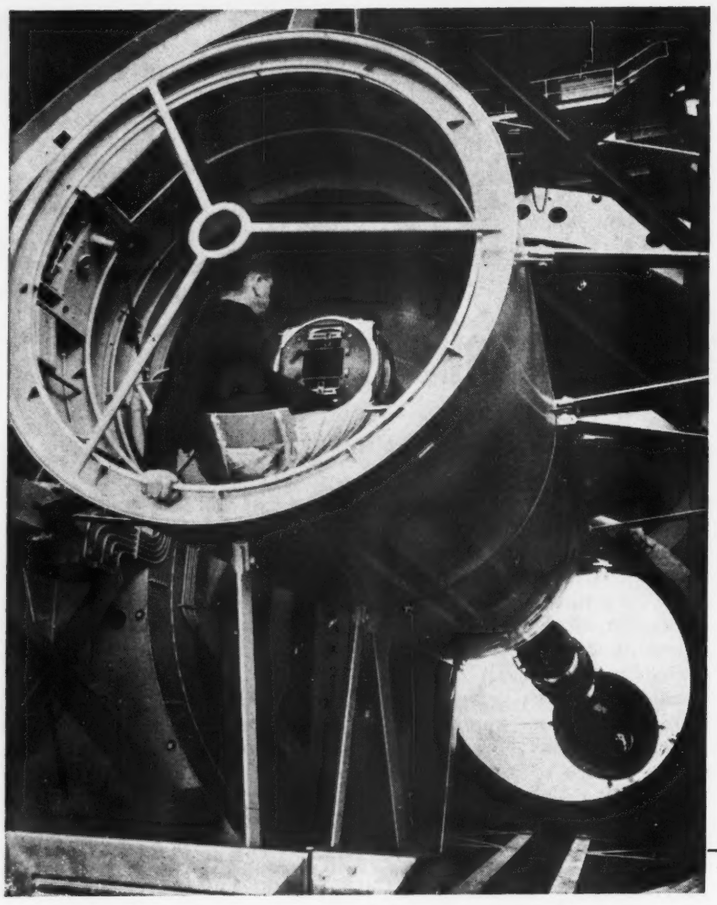
George Field, '51, has been a workhorse on *T. E. N.*'s lit staff for some time now. When a conference came up with the idea of a story which would "eliminate the need for a course," George came up with his article on Nomography—guaranteed to introduce you to course D-31 and perhaps save you some time when beset by troublesome equations.

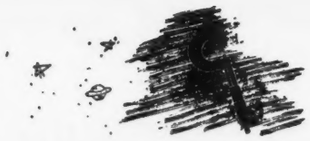
M. I. T.'s Acoustics Laboratory sprang up during the war, and *T. E. N.* has been meaning to tell its readers about it for some time. When it was discovered that **Dan von Recklinghausen, '51,** spent his summer working there, we knew we had an article. We did, and here it is. From the Food Technology department comes the tale of the "Radarange" and its effect on what makes food good for you. Perhaps you have already met quick-cooked hot-dogs. If so you will be glad to know what happens to the frankfurter.

The sad tale of the "Engineer and the Lost Trait" was read to a *T. E. N.* staff dinner group once. All present thought that **Dan Test's '50** Tau Beta Pi initiation paper might provide food for thought for someone. Speaking of Tau Beta Pi, "Capital Export," written for last May's Tau Beta Pi issue and held over for lack of space at that time, seems ever so much more apropos now. Ease in exporting know-how and industry might make a large difference in the present sad international financial condition.

Why, Daddy?. . .

Can anybody tell me why statistics (quoted in *Collier's*) show that over the past seventeen years there has been a direct relationship between the value of insurance policies held and the height of the insured? It might be interesting to find an explanation for what appears to be stretching coincidence a little far.





1,000,000 pounds that move with micrometer precision on SKF Ball and Roller Bearings

The new telescope at Mt. Palomar moves its massive 500 tons with pin point precision on SKF Ball and Roller Bearings . . . over 5,500 SKF Bearings in all.

This is another of the interesting and imaginative assignments that cross the desks and drawing boards of the SKF Engineer. SKF Industries, Inc., Philadelphia 32, Pa. 6736

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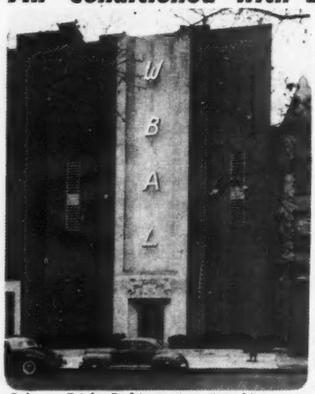

Below: Frick Refrigerating Machines at Radio Station WBAL

The new building of Maryland's largest broadcasting and television station, at Baltimore, is air conditioned throughout with three Frick compressors, each having four cylinders, as shown below. This fine installation won the 1948 Building Trades Award for the Paul J. Vincent Co., Baltimore Distributors for Frick Refrigerating, Ice-making and Air Conditioning Equipment.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

capital export

(*Continued from page 9*)

and will not easily be forgotten. The prospect of nationalization of industries is now also a major factor for consideration. Experience has shown that, when a government "confiscates" or in any other manner takes possession of the business of a non-resident, the non-resident does not receive equitable compensation. Thus the possibility of disastrous changes in government policies is another severe deterrent to capital exportation.

The principal difficulties which must be overcome in successful overseas operation have been briefly described. Steps are being taken and proposals made to relieve the situation in areas where agreement can be obtained.

The International Monetary Fund has been established with the intention of stabilizing exchange rates. Participating countries are required to deposit an amount of gold and currency with the Fund, and the Fund arrives at a value of the country's currency in terms of gold or United States dollars. An exchange rate is in this manner set up which the individual nations are pledged to maintain within certain margins. Within limitations, the Fund will buy and sell currency and gold to assist in keeping the established rates. The arrangement theoretically insures each nation of a reasonable supply of any money. Failure to live up to the agreement is punished by forced abstention from participation. The work of the fund has not been entirely successful, but it represents a step in the right direction.

Let's get down to earth . . .

IMAGINE stealing three billion tons of earth every year! That's what soil erosion has been doing. And this gigantic theft has cost farmers billions of dollars. For good earth is *not* dirt cheap.

"Stop erosion!" has become the farmers' war cry. Agricultural agencies have joined the farmers. Together, they have turned to the farm machinery makers. They've asked for bigger and better bulldozers, tractors, graders for necessary ditching and terracing. But to build this super farm machinery takes tougher steel, *new alloys.*

Here is where UCC enters the allied offensive against erosion. Drawing on its vast engineering experience, UCC contributes modern metallurgical techniques and alloys. This co-operation with steel manufacturers helps the farm machinery makers . . . who then are able to give the farmers the equipment they need.

How is the "war" going? The farmers are winning. Dust bowls are vanishing. Sterile lands show signs of life. Yes, the farmers are winning their fight against soil erosion with a combination of new equipment, revegetation and crop rotation.

Union Carbide is proud of its part in this effort. And the people of UCC stand ready to help solve other problems . . . wherever better materials and processes are needed.

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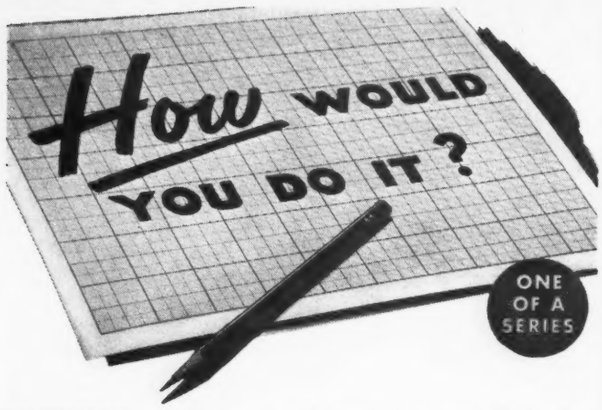

PROBLEM — You are designing a machine for doing finishing operations on the production line, such as grinding, polishing, buffing, etc. Your problem is to provide a drive that permits the grinding or polishing wheel to be moved around freely while it is running. How would you do it?

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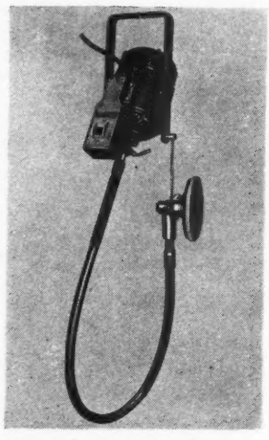

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some useful lines

(*Continued from page 20*)

the chart for adding reciprocals. This operation is common enough so that the nomographers have devised radial scales which solve it in good fashion. If

$$\frac{1}{f_1(x)} + \frac{1}{f_2(y)} = \frac{1}{f_3(z)}$$

is to be solved, we draw the x and y scales converging at their common origin, O. The z scale is also radial; its angular position is determined by the fact that $\frac{L}{1} = \frac{m_y}{m_x}$ in Fig. 6, L being parallel to the x scale. To calibrate the z scale one plots a temporary z scale having various distances L along the y line according to the relation:

$$L = m_y f_3(z).$$

Finally this temporary scale is projected onto the z line in a direction parallel to 1.

Fig. 7 shows a well-known optics equation:

$$\frac{n_1}{u} + \frac{n_2}{v} = \frac{n_2 - n_1}{R}.$$

The idea behind the nomogram is simple: the straight-edge reading of scales. It is therefore widely applicable. We have touched on but a few of the many known forms; others make a specialty of division of differences by sums, for instance. Cartesian graphs are often used along with parallel scales, and a modification of rectangular coordinates solves proportions having four terms. With a bit of geometrical aptitude and experience one can design nomograms to meet new problems.

World's fastest automatic changer—in RCA 45 rpm system—changes records in 5 seconds.

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Remarkable, too, are the new records—only 6⅞ inches in diameter—yet giving the playing time of conventional 12-inch records. Unbreakable, these compact vinyl plastic discs use only the distortion-free "quality zone"... for unbelievable beauty of tone.

Value of the *research* behind RCA's 45 rpm system—which was started 11 years ago at RCA Laboratories—is seen in the instant acceptance, by the public, of this better way of playing records. Music lovers may now have *both* the 45 rpm system, and the conventional "78."

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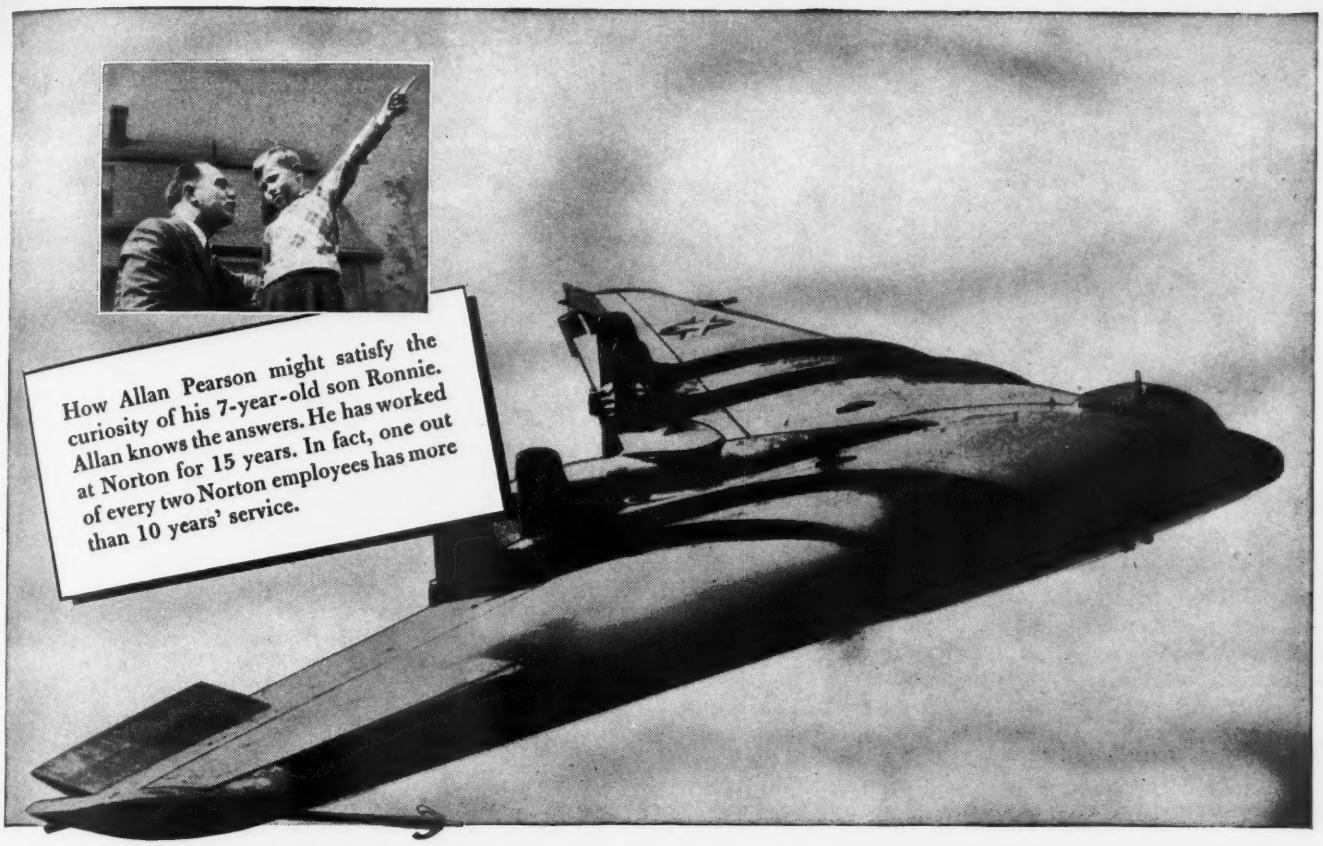
How Allan Pearson might satisfy the curiosity of his 7-year-old son Ronnie. Allan knows the answers. He has worked at Norton for 15 years. In fact, one out of every two Norton employees has more than 10 years' service.

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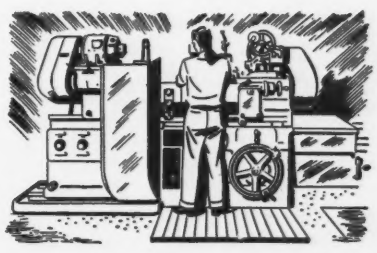
"Then those engine parts are shaped smooth and true by Norton grinding wheels. And those parts fit each other just right. That's because of the sure finishing touch of Norton grinding wheels and machines.



"And when that giant lands, it lands safely because Norton engineering created a special grinding machine that helps make the landing gears' odd-shaped parts fit true and tight and strong."

"Yes, Ronnie, Norton helps make airplanes better. Other products, too. In fact, there's hardly anything man makes that doesn't get a lift from Norton somewhere along the line. That's why I'm proud of my job of making better products to make other products better."

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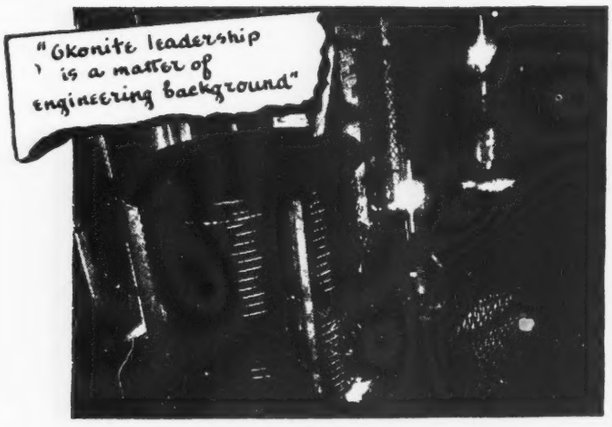

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OKONITE SINCE 1878

insulated wires and cables

from studios to polymer fractions

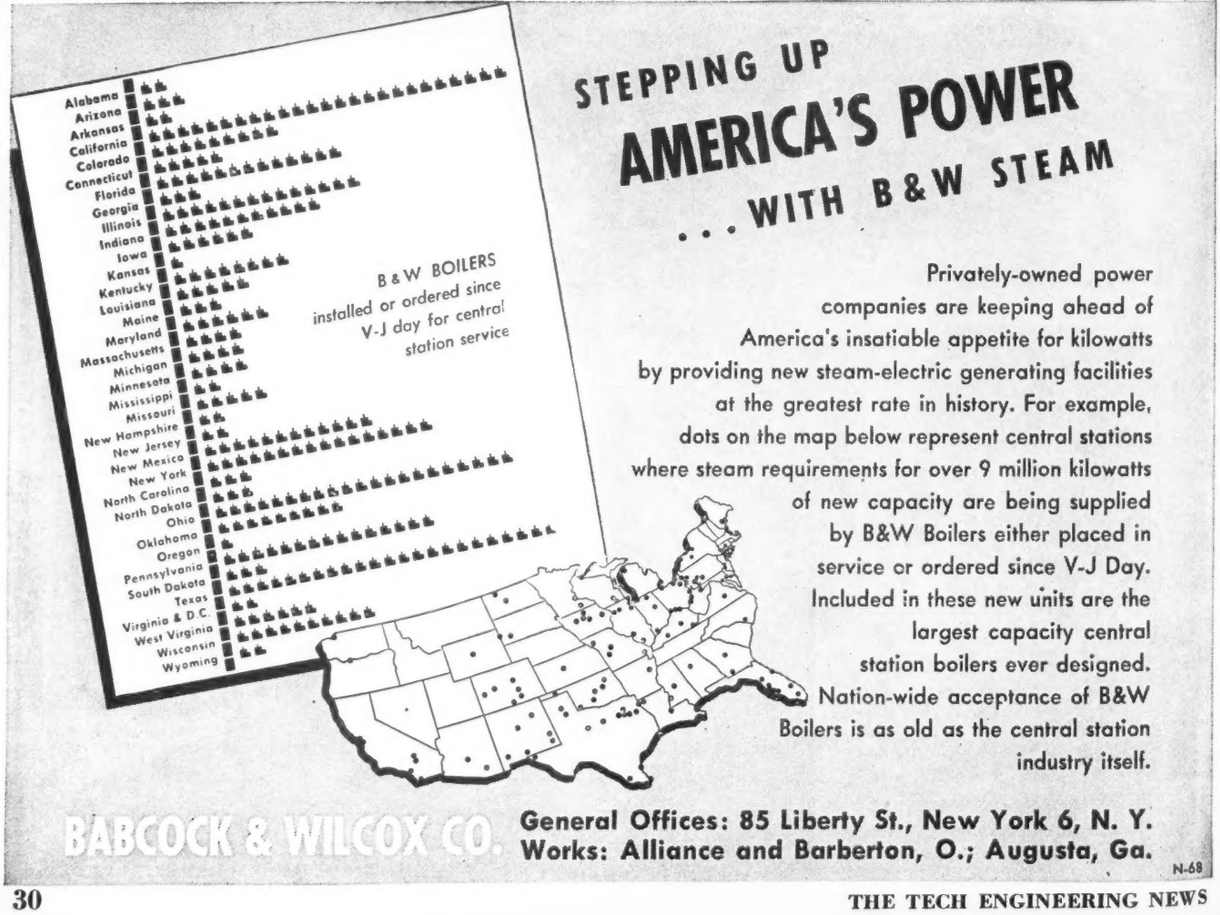
(*Continued from page 11*)

field in the material being irradiated. Optical rotation of sugars, absorption of materials, and depolymerization of polymers are all included in research with the lab's generator. Not the least important piece of research being done in this field is the study of brain tumor location with high frequency sound; the lab is cooperating with researchers at the Massachusetts General Hospital on this.

Of direct interest to the physics department is the study being made with the help of the crystal generator and other apparatus of the chemical and physical effects of intense sound irradiation — the stresses produced in materials and sound absorption by solutions and gels with regard to molecular structure, for example. Cavitation in liquids in intense sound fields is being studied under rigidly controlled conditions.

For visual observation of data in the study of sound fields cigarette smoke is used (Listen carefully, we have arrived). In one experiment a set-up was developed which would have made a good substitute for the face which blows smoke rings high above city streets. Study of these rings gives data valuable in the study of how sound travels. Smoke is also used, in smaller quantities, to determine the displacement amplitude of particles of the medium through which sound is traveling.

The Acoustics Laboratory at M. I. T. is a fairly recent institution, but it fills what was once a rather large gap in scientific training and study. Since it has come into existence, it has been consulted on many matters by researchers and interested persons in other fields. One group has even asked the lab for a method of eliminating the pigeon menace with ultrasound. (Note: It does not work.)



STEPPING UP AMERICA'S POWER . . . WITH B&W STEAM

Privately-owned power companies are keeping ahead of America's insatiable appetite for kilowatts by providing new steam-electric generating facilities at the greatest rate in history. For example, dots on the map below represent central stations where steam requirements for over 9 million kilowatts of new capacity are being supplied by B&W Boilers either placed in service or ordered since V-J Day. Included in these new units are the largest capacity central station boilers ever designed. Nation-wide acceptance of B&W Boilers is as old as the central station industry itself.

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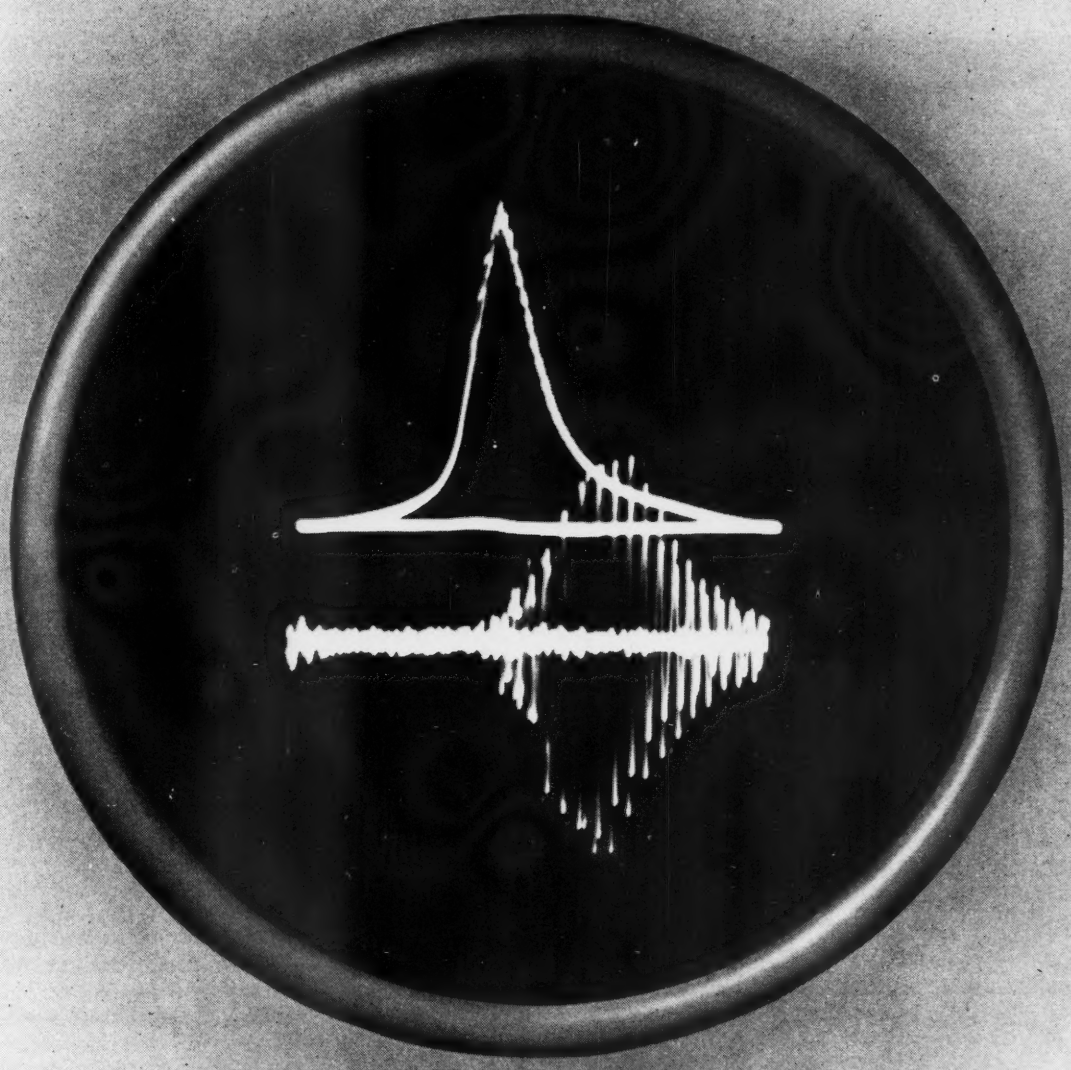


This is a picture of "PING"

It's a picture that gives automotive engineers clear-cut facts on performance—a picture that suggests how photography with its ability to record, its accuracy and its speed, can play important roles in all modern business and industry.

No, this is not the "doodling" of a man on the telephone. Far from it. It's the photographic record of an oscilloscope trace that shows, and times, detonation in a "knocking" engine. It all happens in a few hundred-thousandths of a second—yet photography gets it clearly and accurately as nothing else can.

Oscillograph recording is but one of countless functional uses of photography in bettering products and improving manufacturing methods. High speed "stills" can freeze fast action at just the crucial moment—and the design or operation of a part can be adjusted to best advantage.

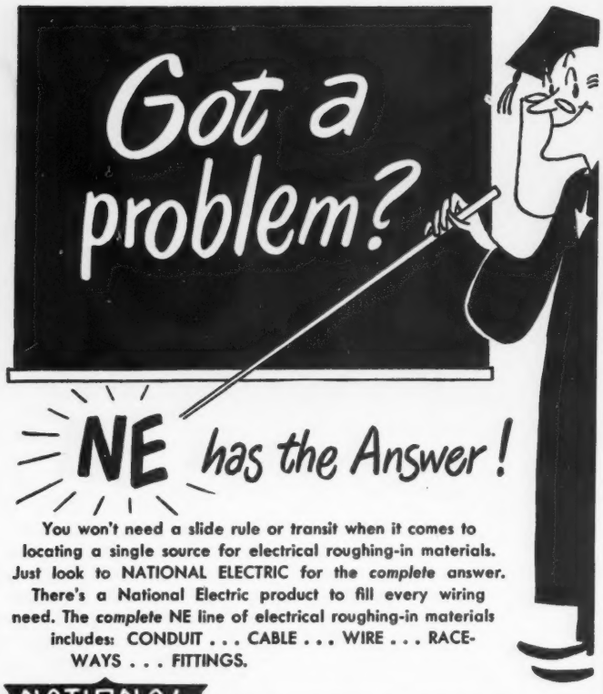
And high speed movies can expand a second of action into several minutes so that fast motion can be slowed down for observation—and products be made more dependable, more durable.

Such uses of photography—and many more—can help you improve your product, your tools, your production methods. For every day, functional photography is proving a valuable and important adjunct in more and more modern enterprises.

Eastman Kodak Company, Rochester 4, N. Y.

Functional Photography . . . is advancing industrial technics

Kodak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sixty second sizzling

(*Continued from page 21*)

Some of the results of this investigation are depicted graphically in Figure 2. It is apparent that practically no loss was sustained in Vitamin C content by any of the vegetable when subjected to radar treatment for the time periods necessary to raise the temperatures of the vegetable sufficiently to inactivate their enzymes. The rapidity of blanching by radar energy as compared to conventional methods is illustrated in the following table.

OPTIMAL TIMES NEEDED TO BLANCH VEGETABLES IN RADAR OVEN, BOILING WATER, AND STEAM

Vegetable	*Optimal Time for Blanching*		
	Radar Oven	*Boiling Water*	*Steam*
	Seconds	Minutes	Minutes
Spinach	20	2.5	3.5
Carrots	25	3.0	3.0
Peas	25	1.0	2.0
Green Beans	20	2.0	2.0
Broccoli	30	3.0	4.0

Thus it may be seen that radar offers a means of blanching which is much more rapid than conventional means and which is also extremely favorable from the point of view of conservation of soluble nutrients. Blanching procedures using radar equipment may be conducted on food samples packed in flexible thermoplastic containers. During later cooling these containers served as protection against vitamin losses that might otherwise have occurred if the cooling water had been used in direct contact with the blanched raw materials. For example, two ears of corn-on-the-cob were placed in a thermoplastic bag and blanched in the radar oven for one minute. The bag was then sealed and cooled by immersion in ice water. The resulting product was found to be completely blanched and of excellent texture and flavor.

Radar ovens have been used for a number of other purposes more recently, including the rapid drying of ink on one of the most popular weekly magazines, for the processing of jams and preserves, for rapid short order cooking in restaurants, and for the drying of pharmaceuticals.

The application of radar energy to the feeding of troops has been studied quite recently. It was found that the electronic oven, although rapid enough on a small scale, did not have sufficient capacity to cook a meal for one hundred men in fifteen minutes.

One researcher found, while evaluating the radar oven for submarine use, that in conversion of electric energy to heat, the radar oven had an efficiency superior to that of the conventional electric range.

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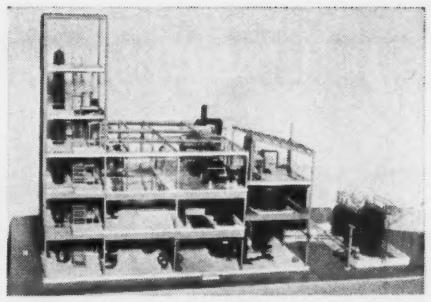
THE DU PONT DIGEST

FOR STUDENTS OF SCIENCE AND ENGINEERING



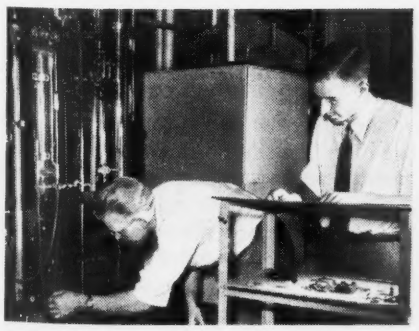
Scale model *of a part of the Du Pont adiponitrile plant at Niagara Falls. Here furfural, an agricultural by-product, is converted into a chemical intermediate for making nylon.*

yarn from corncobs!

A DU PONT PROCESS CONVERTS FURFURAL INTO A CHEMICAL FOR MAKING NYLON

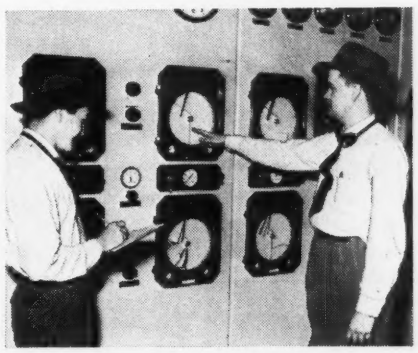
One of the fascinating things about nylon is the unlikely sounding raw materials that go into it. Popularly, nylon is said to be made from coal, air and water. This is because originally, in developing its chemical intermediates, chemists used benzene (from coal), ammonia (from air and water), and oxygen (from air).

But Du Pont is always looking for new ways of doing things. After the discovery of nylon in 1934, research men immediately began looking for alternative ways of making the two main intermediates—adipic acid and hexamethylenediamine. In 1935, when nylon was still in the laboratory stage and three years before its commercial debut, they started work on the possibility of using furfural in the process.



A. G. Sveinbjornsson, *Ph.D., Organic Chemistry, University of Kansas, 1948, and H. B. Copelin, M. S., Organic Chemistry, Cornell, 1941, studying new furfural derivatives.*

Furfural has been used in the chemical industry for 25 years, but it is little known to the layman. A tan-colored liquid with a faint bitter-almond odor, it is made from a wide variety of agricultural by-products. Among these are corncobs and hulls of cottonseed, oats, rice—all available in practically unlimited quantities from America's farms.



C. R. Dewey, *B. S. Chem., Niagara University, 1941, and J. M. Estes, B.S. Ch.E., University of Missouri, 1937, engaged in production of adiponitrile at the Du Pont Electrochemicals plant in Niagara Falls, New York.*

14 Years of Research and Development

It seems a far cry from corncobs to nylon, and it was. The development from the first small-scale laboratory experiments to the present full-scale plant cost 14 years of time and about five million dollars. But it enabled chemists to produce large quantities of adiponitrile, the compound from which hexamethylenediamine is made, by an economical process which uses natural materials that are in continuous supply.

In the new process, furfural is converted by a series of steps to 1,4-dichlorobutane. The next step explains in part why Du Pont undertook the project in the first place. As producers of cyanides, they had sodium cyanide available for converting the 1,4-dichlorobutane into adiponitrile.

The final product, hexamethylenediamine, is then reacted with adipic acid to make nylon "salt." Still more processing and the salt becomes yarn, and the nylon flake used by the plastics industry.

Opportunities at Du Pont in many scientific fields

This is an excellent example of the interesting work in industrial organic chemistry carried on at Du Pont. It required the technical knowledge and skill of highly trained research and development men, including organic and physical chemists; chemical, mechanical, civil and electrical engineers, and others.

Only a large company with ample resources in men and money could afford to engage in research of such magnitude. To the young college graduate, Du Pont offers the broadest of opportunities in many scientific fields, along with the advantages of working directly with a small group of associates.

Keynote of Du Pont personnel policy is promotion from within on a competitive merit basis. A conscientious effort is made not only to choose college-trained people of promise, but to develop each individual as rapidly as possible.

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Extrapolation, Interpolation, and . . .

Dr. Norbert Wiener, professor of mathematics at the Massachusetts Institute of Technology, has written a new book entitled "Extrapolation, Interpolation and Smoothing of Stationary Time Series." The new book represents an attempt to "unite the theory and practice of two fields of work . . . which have up to the present drawn their inspiration from two entirely distinct traditions . . ." These two fields are those of "time series in statistics and of communication engineering." The book consists mainly of the development of a mathematical attack which can profitably be applied to both of these fields.

Temper, Temper . . .

A new tempering process makes it possible to heat a metal surface from room temperature to 1600 degrees Fahrenheit and then cool it to room temperature, all in less than five seconds.

The process is used for the tempering of small metal parts such as the toothed surfaces of small ratchet wheels for automatic circuit reclosers. Such parts require an efficient tempering process since they must be able to withstand heavy impacts.

An electromagnet is used to hold the part to be tempered within the field of a powerful electronic heater. An automatic timing switch turns off the electronic heater when the part has reached the proper temperature. At the same instant, the current is removed from the electromagnet and the part drops into a cooling bath of oil.

Prestressed Concrete . . .

The use of prestressed concrete has been developed in Europe to the point where it will soon be extensively used by American engineers.

The prestressing converts the concrete into an elastic material. The weakness of concrete in tension and its consequent cracking should be greatly lessened by this process. The entire prestressed concrete section carries bending moment and therefore such a beam can carry much heavier loads without failing than can a reinforced concrete beam of the same section.

It would also be possible for a prestressed concrete beam to span greater distances than has heretofore been possible.

The new beam structure lends itself to closely controlled mass production techniques.

Prescriptions . . .

A thorough analysis of some thirteen thousand medical prescriptions collected in thirty-nine states in November of 1946 shows that, with regard to frequency of use, the top four ingredients were thiamin hydrochloride, riboflavin, phenolbarbitol, and glycerin.

Experimental Wall . . .

The National Bureau of Standards has recently erected an experimental wall faced with over two thousand specimens of stone from forty-seven states and sixteen foreign countries. The wall will be used to study various important structural problems, such as discoloration, waterproofing, and dimensional stability.

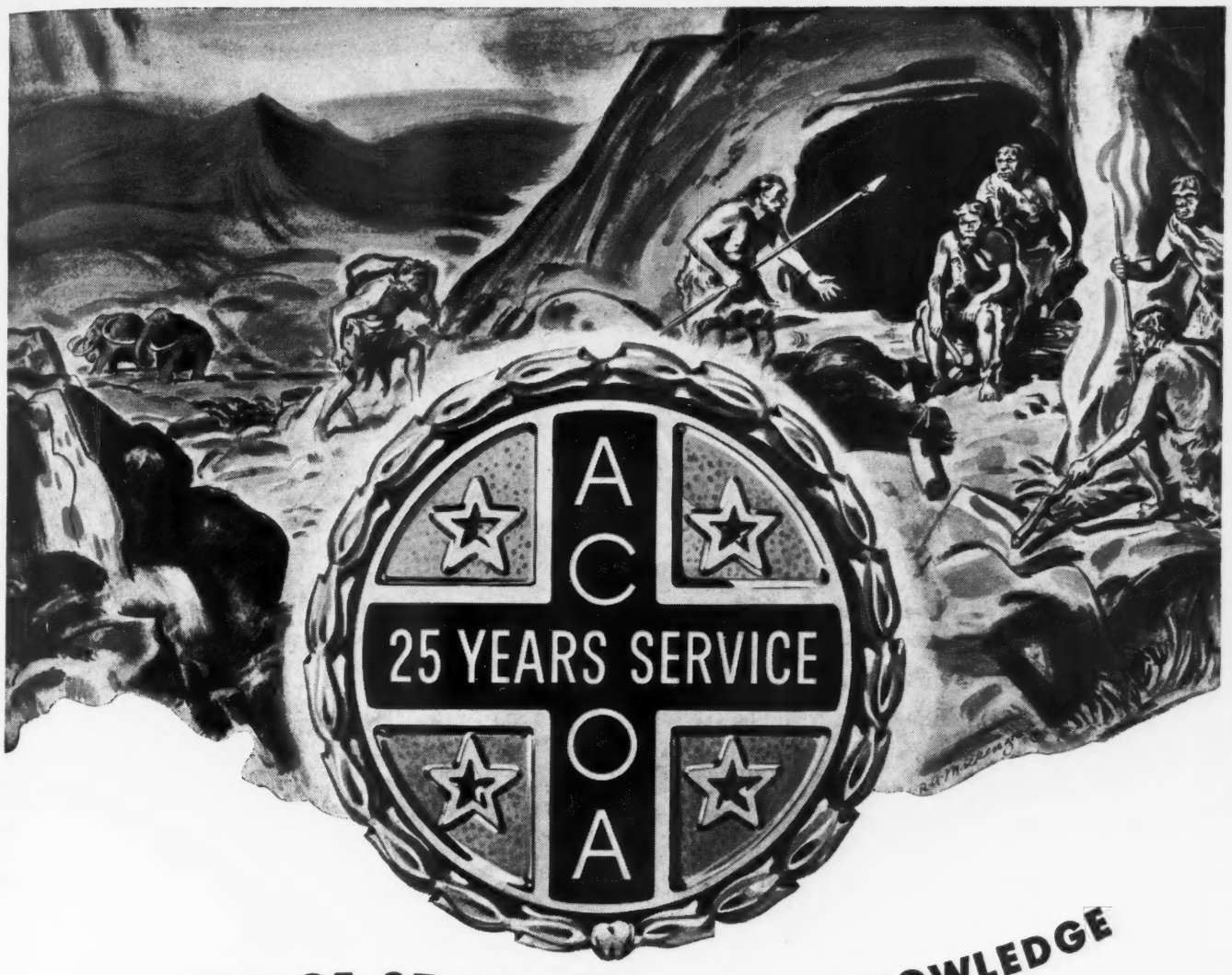
In all, the wall contains thirty distinct types of stone, some of which are not common building materials. The bureau may find wider usage for the latter if they prove to have desirable characteristics.

There'll Be a Hot Time . . .

A fire has been burning since last March in a coal mine in Alabama. Strangely enough, the fire was started intentionally and no efforts have been made to extinguish it. The purpose of the blaze is the production of gas.

The progress of the fire is being followed through use of an electronic mercury vapor detector. Small capsules of mercury are placed at regular intervals throughout the coal vein. When the fire reaches a capsule it vaporizes the mercury and an instrument detects the presence of the vapor.

The mercury vapor detector takes advantage of the fact that ultra-violet light is scattered when it passes through an atmosphere containing mercury vapor. Gases to be tested are passed through a tube between an ultra-violet light source and an electric eye. If the gases contain mercury vapor the light reaching the electric eye will be lessened and the instrument will record the presence of the vapor.



SYMBOL OF 85,000 YEARS OF KNOWLEDGE

If you had been born 85,000 years ago and were still alive, think of all you would know about what happened on earth.

And if you had devoted all those years to working with one particular material found on earth . . . say aluminum . . . think what you would know about that.

Actually, man has known of aluminum for less than 150 years and didn't really start to use it commercially until 1888 when Alcoa started producing it. Yet in Alcoa's employ today is a group of men and women who possess a total of 85,000 years of aluminum working knowledge.

These people, 2,900 of them, proudly wear this button as members of the Alcoa 25-Year Service Club. Many have been in the family longer than 25 years. Their jobs range all the way from mill hand to president, from engineer to chairman of the board. They are a fourth of all the employees Alcoa had 25 years ago, pretty good indication that it's "a good company to work for".

But here's the most significant point: Sixty-one years ago, when Alcoa started, only five men were employed. Today about a million people have jobs in the aluminum industry, an industry comprised of: companies who produce aluminum from ore; companies who smelt aluminum scrap; others who make semi-finished aluminum products; and hundreds of companies who manufacture useful articles in which aluminum plays an essential part.

Today the same pioneering spirit that marked the founding of this industry is evident in Alcoa's laboratories, mills and foundries. Here men are developing new uses, new techniques that promise even more for the future of aluminum. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

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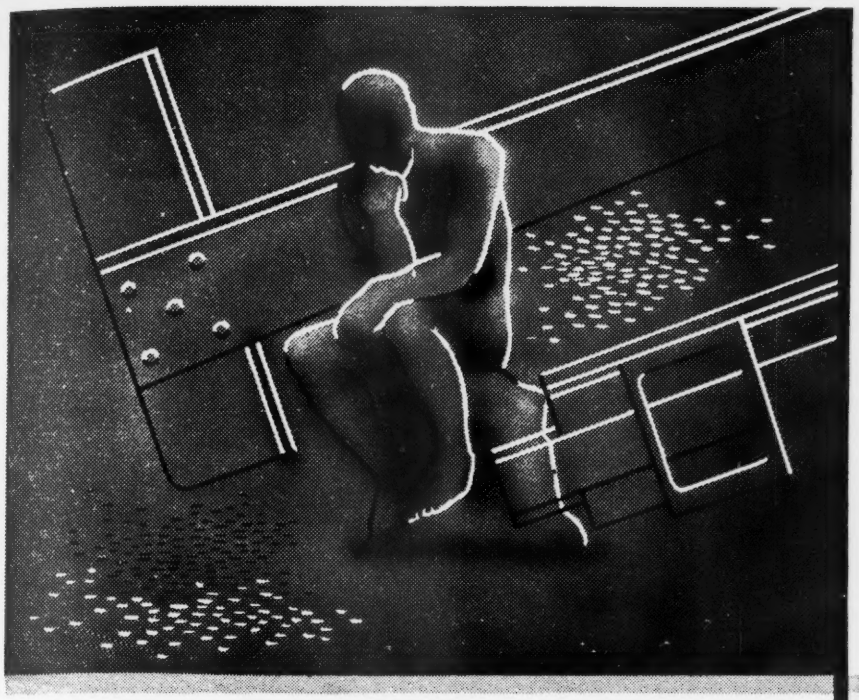
Graduate study may be pursued in Textile Technology, Ceramics, Sanitary Engineering, and in most of the above professional Courses. The Master's and Doctor's degrees are offered in most of these fields.

For information about admission, communicate with the Director of Admissions.

The Catalogue for the academic year will be sent free on request.



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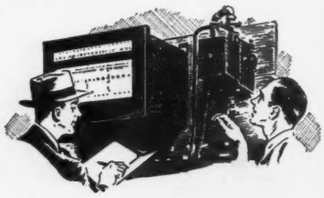

TYPICAL SOLUTION *was development of first "turbidimeter," advancing work on water-purification equipment.*

1000 Specialists tell us "When you can measure..."

Lord Kelvin, writing in 1883, summed up once and for all the importance of measurement.

"When you can measure what you are speaking about," he said, "and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

The need for detailed and accurate "numbers" is as great today as it ever was. Recently, for example, General Electric engineers working on water-purification equipment were hindered by the lack of any accurate way to measure water's turbidity. Another group needed data on the vibrations in their equipment.

But at General Electric any group up against tough measurement problems does not have to be stymied for long. It can "appeal" its case, can seek the aid of men who make a specialty of measurement and allied problems—the more than 1000 staff members of the G-E General Engineering and Consulting Laboratory. GE & C serves the entire company, and is also frequently called on by other industries and government agencies.

It solved the two problems above by developing the first "turbidimeter" and a "recording vibrometer" now finding applications throughout industry—two out of thousands of similar problems handled by the laboratory each year.

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